WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

"Some Water Works Lessons Learned from the Depression," by Myron B. Reynolds, City Engineer, Chicago, reveals some striking facts heretofore not considered in probable effects secured through meterization and the wisdom of developing long term programs for betterments with suggested methods of capitalizing on public relations.

In this issue *A. M. Rawn*, Assistant Chief Engineer, Los Angeles County Sanitation Districts, tells of some of the aggravating characteristics of sewage. In the November issue Messrs. F. D. Bowlus and A. P. Banta, engineers on Mr. Rawn's staff, will describe measures employed to successfuly correct difficulties with sewage conditions in Los Angeles County, in an article on the *"Control of Sewage Conditions by Chlorination."*

"Water Supply Practice and Treatment for Railway Systems," by R. C. Bardwell, Engineer in Charge of Water Supply, Chesapeake & Ohio Railway System, will describe the various methods of securing water supply for railroads and the importance of water of proper quality for steam locomotives. In a second article, Mr. Hardwell, who is an authority on railroad water supply practices, will discuss methods employed in treatment of railway supplies and its relationship to operating economy.

"Sewage Treatment at High Point, N. C." is the title of an article by E. H. Moss, Superintendent of Plants at High Point, and C. W. Mengel, Wm. C. Olsen, Engineers, of Raleigh, N. C., who designed the two sewage treatment plants. The operating results and operating costs will be set forth for the sprinkling filters and separate digestion plant employing sludge beds for comparison with the same from the newer activated-sludge plant employing sludge dewatering on vacuum filters.

W. E. Stanley, Superintendent and Chemist, San Antonio Sewage Treatment Works, will describe the San Antonio plant and give operating experiences and operating costs in a series of short articles. The author was formerly chemist at the Houston, Texas, plants and is well equipped to discuss the many phases of the activated sludge process.

A short article by John R. Downes, Supervising Engineer, Plainfield, N. J., Sewage Treatment Works, deals with a practical method of *"Disposal of Humus Sludge from Secondary Tanks."*

E. T. Cranch, Superintendent, New Rochelle Water Company, New York, will continue with a series of articles on water works maintenance and operating problems. The next article will deal with maintenance and repairs of fire hydrants.

George D. Norcom, Sanitary Engineer, Federal Water Service Corporation, will report on experiences with absorbent clays in taste removal and coagulation improvement.

John R. Baylis will continue discussion concerning evaluation and the properties of activated carbons.

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Published monthly by the GILLETTE PUBLISHING CO., Daily News Building, Chicago, Ill.

Entered as Second Class Matter, June 2, 1931, at the Post Office at Chicago, Ill., under the Act of March 3, 1879. Published monthly at 400 W. Madison Street, Chicago, Ill. Per copy 25c. Subscription rates $2.00 per year. Canadian and Foreign, $3.00 per year. Copyright, 1932, by Gillette Publishing Company, Publishers of: Engineering and Contracting, Water Works and Sewerage, Roads and Streets, Oil and Soap, Motive Power, The Art of Mosaics and Terrazzo, Road and Street Catalog and Data Book, Water Works Catalog and Data Book.

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Chicago Office, Daily News Building. Cleveland Office, 953 Leader Bldg. New York Office, 420 Lexington Ave. San Francisco Office, 703 Market Street.

Addresses will be changed as frequently as desired, upon notification; not otherwise. Changes of address should be sent in at least two weeks before the date of the next issue of *Water Works and Sewerage*, in order for them to be effective for that number. Immediate notice should be given of any delay in the receipt of the magazine.

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By
EDWARD S. HOPKINS
Principal Sanitary Chemist, Bureau of Water Supply, Baltimore, Md.

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—Excerpts from the Foreword

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WATER WORKS AND SEWERAGE

VOL. 79 — No. 10 — OCT. 1932

A GILLETTE PUBLICATION

PURIFICATION OF PUBLIC WATER SUPPLIES IN THE ORIENT

By JAL D. EDAL BEHRAM, M. Sc., A. I. I. Sc., A. I. C.

Chemical Engineer,
36 Haman St., Bombay, India

Jal D. Edal Behram contributes this article based upon information gathered during travel through the Orient, visits to various waterworks, and his experiences during nine years of service as Chemist and Bacteriologist at the Shanghai Water Works in China.—Editor.

THE necessity of purification of public water supplies has been appreciated for some time in the orient. All fair sized municipal bodies in India own a waterworks, but the standard of service is more or less dependent on the availability of funds and the civic sense of the citizen. Indian cities are still not fortunate enough to have a full pressure 24-hour supply. Cantonment cities in India are more fortunate in this respect, as the safeguarding of the health of troops is a vital matter.

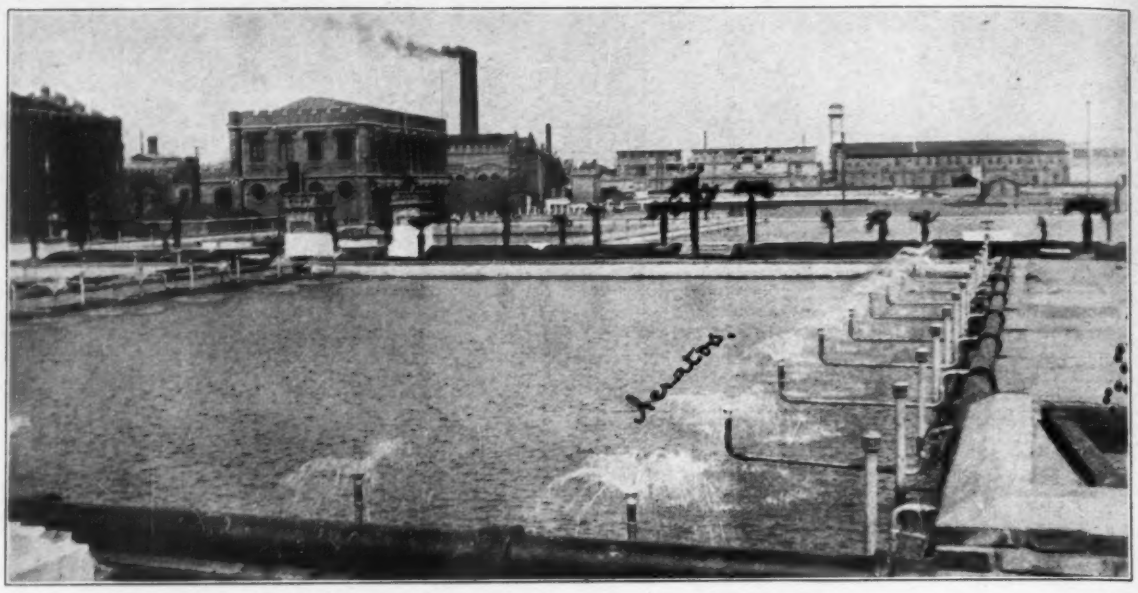
In China, cities under Chinese control as distinguished from treaty-ports, have a large Chinese population and have not generally appreciated the amenities of a waterworks. The capital city of China which is now Nanking, has a scheme for a waterworks just under way. The treaty ports all own a waterworks. As a result of British enterprise, the ever progressive city of Shanghai gave to its citizens a public water supply as early as 1881. Slow sand filtration of the Whangpoo River water was adopted, which system was continued to 1919, additions being made to the plant as necessity arose. The outlying districts where the water plant is situated, once fields and picnic spots, became a thriving industrial center with cotton mills, engineering works, paper mills and a super-generating station. Non-availability of ground for extensions and advances in water purification methods resulted in intensification of purification processes by chemical treatment.

An idea of the magnitude of the undertaking may be had from the fact that The Shanghai Waterworks Company supplied to the International Settlement and outlying districts an average daily consumption of 39.5 million gallons, the maximum daily consumption in the hot weather being 53.5 million gallons in the year 1930.

The Shanghai area has vast underground sources of water which are of a very high degree of purity bacteriologically (Lactose fermenters absent in 100 c.c.s.), but are hard and contain iron. Private borings have been much in vogue and at one time these became serious competitors to water companies.

In Manchuria, the Kwantung Government and the South Manchurian Railway Co. started to provide modern waterworks in the leased territory and the Railway Zone. The Russian regime provided waterworks at Port Arthur, Dairen and a few other places for the use of Russian troops and railways.

Dairen has an up-to-date waterworks with a capacity of 5.5 million gallons per day. The cost of the waterworks at Dairen, Port Arthur and Chinchou came to yen 7,650,000 (1 yen = 48 ct.) and the South Manchuria



Purification Works of the Shanghai Water Works Co.

Ry Co. by 1926 had provided waterworks in seventeen population centers along the railway at an aggregate cost of yen 5,900,000 so that a population of some 275,-000 now enjoy the benefits of a wholesome water supply. These waterworks have paid their way since 1920 only.

The Hygiene Institute and the hospitals examine the drinking water in the railway zone every month and all the wells in the zone twice a year.

The water supply of the beautiful city of Tsingtao originally in German, but now in Chinese hands, is from tube wells bored in a forest valley and is similar in principle to the plant at Wuhlsheide near Berlin. Filtration, chlorination nor softening is necessary.

Water Supply of Small Towns and Villages

Vast as are the oriental countries, but few village communities and small towns enjoy up-to-date water supplies. Village wells supply the water which is hand drawn and carried. This remark applies also to India. In the hot summer months intestinal troubles are prevalent.

China is supplied plentifully with water by nature. There are open creeks all throughout the country, but these are in a very filthy condition and yet are used as the source of the domestic and drinking water supply of China.

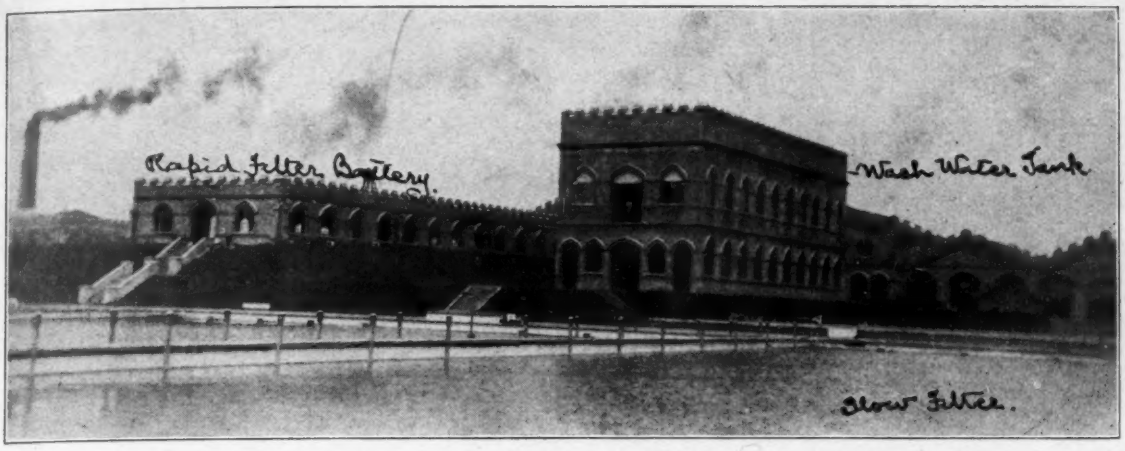
Every home or boat in China has got a "kong," which is a large glazed earthen pitcher in which the water is treated with Chinese alum added. When the water becomes clear, it is used for all purposes, but is never drank as such. It is boiled to make very weak green Chinese tea which is the national drink of the Chinese at all hours of the day. That's why intestinal epidemics are not frequent and take a rather low toll of life in comparison with the number of people.

Water Supplies of Japan

Practically all the water supplies of Japan are properly safe-guarded. Modern purification practice is followed throughout; chemical treatment is in vogue for all supplies that require it. Kobe, Yokohama and Tokio all possess modern waterworks. The supplies are chlorinated and slow filtration methods are in practice where the daily demands are not high. The beautiful mountains of Japan help considerably in providing comparatively pure sources of raw water for treatment.

In the orient the sources of water supply are generally grossly polluted. This remark particularly applies to China, where there is a tremendously large floating pop-

Creeks, Such as This, Are the Main Sources of Water Supply in China



Slow and Rapid Filters at Shanghai, China

ulation staying in houseboats on creeks, canals and rivers, and where with a few exceptions, large towns and thickly populated areas have no sewage purification plans. Besides, the surface waters are heavily laden with silt which to a certain extent exercises a purification effect bacteriologically and chemically because the silt is in a state of natural activation.

Again extreme temperature conditions in North China approaching freezing in the winter months and a maximum of 100° F. in summer bring about a set of conditions with few prallels in other parts of the world. This also applies to several parts of Japan, and is interesting from the waterworks point of view as regards daily demand and purification methods.

Intakes

Local conditions and available finance generally determine the choice of an intake. Political conditions in China have often necessitated the choice of relatively undesirable places as intakes for some of the treaty ports. Indian cities in several instances have spent vast sums of money to collect and bring a good quality of water from long distances. Bombay is an example. Modern purification methods, however, render it possible to employ intakes that are inferior, if the cost of the ideal intake is prohibitive.

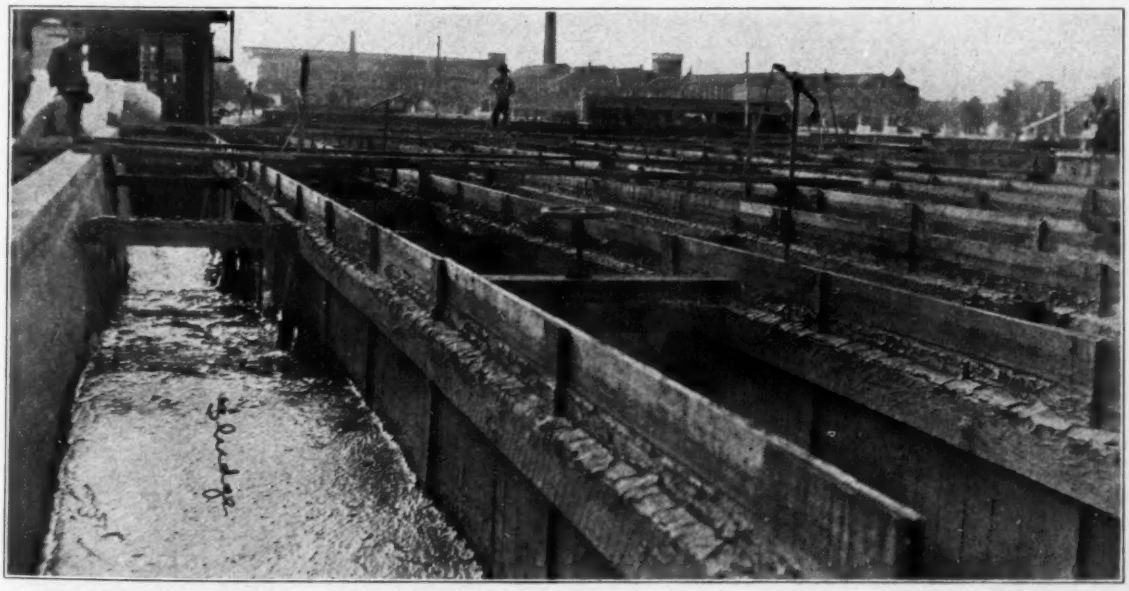
Coagulants and Their Application

By far the most popular coagulant is sulphate of alumina and so far as the orient is concerned the writer does not know of a plant using ferrous sulphate and lime, although it is claimed for certain installations in America that the treatment with the latter is less costly.

Dosage in liquid form is out of vogue, as feeding machines for finely powdered alum are now available. According to a set dosage, the revolving plate of the feeding machine delivers the requisite quantity of the alum powder into a funnel provided with a water injector at its throat. The injector conveys the partially dissolved alum to the point of application. Coagulants are best applied at the raw water pump suction.

Settlement

Plain settlement of water in tanks some 20 ft. deep on the fill and draw principle has now been practically replaced by continuous settlement with the assistance of a coagulant. Modern practice is now in favor of continuous settlement and continuous removal of the settled sludge consisting of silt, organic matter and coagulant flok. The continuous removal of sludge entails the provision of specially constructed bottoms in settling tanks, with either inverted pyramidal pockets, or valleys and ridges, a system of collecting pipes or drains, and valves



An Illustration of the Sludge Problem in Water Treatment Practice in China: Experimental Settling Tank Drained for Sludge Removal

connected to a sludge pump. Catch pits are provided into which the liquid mud is pumped. Settled mud is periodically removed, the supernatant water continuously running off, or at the end of the liquid mud discharge pipe is carried far out towards the direction of stream flow, so that the liquid mud dilutes with the stream water and is carried away without vitiating the quality of the water at the intakes.

Filtration

After the preliminary settlement either plain or with the assistance of a coagulant, and detention period in the settling tanks from four to six hours in the case of chemical settlement, to some 20 hours in the case of plain settling, the water is filtered by passage through a slow filter. The appearance of the plain settled slow filter water varies from season to season as also does the bacterial quality. The winter months yield the poorest quality water physically as the silt laden waters are in a highly colloidal state and difficult to filter during that period. This applies to China.

Section of Slow Filter

Slow filtration methods are still in vogue in many parts, but are fast being replaced as chemical methods have revolutionized filtration practice.

Semi-Rapid Filtration

Plants designed originally to plain settle and slow filter the water have been converted in some places into semi-rapids. A rather liberal dose of sulphate of alumina is applied to create good flocculation and the water is settled on the continuous or the fill and draw principle, but continuous is preferable as a large saving is effected in settling tanks, thereby adding to the capacity, which is more than doubled. When the suspended matter is almost entirely deposited in the settling tank, the settled water is passed through slow filters.

At Shanghai, by this method the slow filters could filter from 8 to 10 gals. of water per square foot per hour, yielding an effluent far superior in clarity and bacterial content to that obtained from filtration of just plain settled influent, which filters at about 2 gals. per square foot per hour.

Where capital is not immediately available and replacement of "slows" by "rapids" has to be deferred in the face of an increasing demand, semi-rapid filtration under the control of a chemist is well worth trying.

Semi-rapid filtered water does not require chlorination as the bacteriological purity of the effluent is very high

Rapid Filtration

In order to clean slow filters, they have to be stopped, drained, the top half-inch of the dirty sand layer has to be scraped, and the surface raked. Before putting the filter back in service the bed is charged with clear water from the bottom and filled with settled water to a height of 3 ft. over the sand. All this means time, at least 36 hours, so that this system of filtration is being fast replaced by rapid filters. This is mostly due to their ease in operation and dependability. Again, small space is required—about one-tenth that of a slow filter—and a rate of filtration is obtained with the rapid filters which is about 40 to 50 times that of slow beds, depending of course on local conditions. Bacteriologically the rapid filter effluents are far inferior to slow filter effluents and chlorination is inevitable. A rapid filter can be back washed and put into commission in less than quarter of an hour.

Double Filtration

An interesting development has been recently reported from Madras which has been having taste troubles in its water supply due to the formation of sulphuretted hydrogen in the effluent, after a slow filter has been in operation from about 15 days to two or three months.

Considerable experimental work was undertaken at the King Institute, Madras, in cooperation with a committee on Madras Water Supply appointed by the Government, to find out the most suitable method of treatment of the Red Hills water, which is the source of raw water for Madras.

The committee published their report recommending passage of the raw water through percolating filters followed by passage through the existing slow filter beds.

The percolating medium comprises 3 ft. of fine gravel 1/10 in. to ¼ in. obtained from a river bed, a top dressing of 6 ins. of ½ to 1 in. broken stone, and a bottom supporting layer of 1 ft. of broken stone.

The filtering sand used for the secondary filters of the usual slow type, is of a grade such that, it passes through 10 meshes and is retained on a sieve of 40 meshes to the square inch.

It is claimed that the final effluent from a slow filter receiving water passed through a percolator is decidedly superior in every respect to an effluent from an ordinary slow bed using unpercolated water. Preliminary percolation greatly diminishes the load on the secondary sand filter and not only allows it to be run at twice the rate, viz., 4 gals./sq. ft./hr, but also prolongs the filter run. The rate of passage through the percolator is 12 gal./sq. ft./hr. Double filtration renders chlorination unnecessary so that the cost of chemicals is saved.

Suphuretted hydrogen the chief cause of the taste trouble, has been entirely eliminated, as the continuous

operation of a percolating filter suite throughout the year, showed entire absence of the gas and the objectionable taste in the effluent. A high quality of the effluent chemically and bacteriologically was maintained.

The costs in connection with the above plant are interesting. Rapid filtration plant including double pumping plant in chlorination was estimated at Rs. 9,80,000 with a maintenance cost of Rs. 1,55,000 yearly (1 Rupee = 36 ct.) and a net filter capacity of 20 million gals. per day. The addition of percolating filters with double pumping now recommended is estimated to cost Rs. 500,000, maintenance Rs. 85,000 with a gross capacity of the existing filters 35.8 million gals. at a little over 4 gals./sq. ft./hr. filtration rate. This results in a saving of Rs. 4,80,000 capital cost and Rs. 70,000 yearly in maintenance charges with the addition of a reserve capacity to the plant of 15.8 million gals. For the above information regarding Madras, the writer is indebted to the four reports by the committee on water and sewage purification published by the Local Self-Government Dept. (Public Health) of the Government of Madras.

Chlorination

The safeguarding of supplies by chlorination is now almost universal. Madras is the only city that the writer knows of that is about to give up chlorinaiton and depend entirely on biological purification. Almost all filtered and unfiltered supplies of India are now chlorinated. Vacuum type Wallace & Tiernan chlorinators are in great favor in the far east. They are dependable in operation and give far less trouble than the pressure types.

Several cities have adopted chlorination in China. Shanghai was the first (1919) to introduce chlorination into China.* Dosages applied by Shanghai vary between .25 to .5 p.p.m. according to season and nature of water. Absence of lactose fermenters in 100 c.c.s is maintained as a standard, but Shanghai water even when tested in quantities of half a litre in one lot, shows no lactose fermenters. Looking at the grossly polluted source which is from a tidal river carrying heavy shipping traffic, Shanghai water is remarkably purified by coagulation, continuous settlement, rapid filtration and double chlorination, viz., as it leaves the filters and at the pumps. This is a result of a forward policy and intensive research.

Bleaching powder is no longer in use for water sterilization purposes. Liquid chlorine has found favor and has to be imported from Europe or America, as no plants for chlorine manufacture have been put up in the East.

▼

The Rapid Development of Patina on Copper

The green patina, that develops through natural weathering of the exposed surfaces of copper, was greatly admired by architects of early days and tradition tells of various unusual methods used to accelerate its formation. None of these was successful. Now a process has been developed by means of which copper and certain copper alloys may be given an adherent green surface coloring, which is practically identical in composition and appearance with the patina that forms on copper surfaces after a period of years when exposed to the atmosphere. These synthetic patinas are believed to be permanently resistant to weathering. To date specimens exposed to a severe industrial atmosphere for a period of over six months during which time they were wet down by heavy showers four times daily, have shown no change or lack of adherence. Similar specimens exposed to a strictly marine atmosphere for five months, including severe winter weather, have shown no failure or tendency of the patina to break down.

Patina has traditionally but erroneously been considered to be copper carbonate. In the fall of 1928 samples of copper roofing were removed from the railroad station at Providence, R. I., from Woolsey Hall at Yale University and from a factory building and a residence at Waterbury, Conn. The results of the analyses of the patinas on this copper were surprising in showing that in every instance the patina was a basic sulphate rather than basic carbonate. Independent studies made at about the same time had revealed that the patina on copper roofs on some of the oldest structures in England was also basic sulphate.

Through experimentation it was found that copper exposed to a spray of ammonium sulphate solution for about 24 hours acquired a dark green adherent patina. Alternate immersions in the solution resulted similarly. A continuous immersion would not produce results, indicating that the formation of the patina was intimately associated with an oxidizing action of the atmosphere combined with the ammonium sulphate attack.

Based on these discoveries a commercially practical process described has been worked out. The patina may be applied in about 24 hours as compared to the 12 to 14 years required in natural weathering. The color of the patina on completion is a dark-blue green, but changes gradually on exposure to the lighter natural shade.

The above has been taken from an article by John H. Freeman, Jr., and P. H. Kirby in *Metals and Alloys*, September, 1932.

▼

John R. Freeman

JOHN RIPLEY FREEMAN, noted hydraulic engineer, died at his home in Providence, R. I., on October 6, in his 77th year. He served his profession for 56 years.

His technical achievements included service as consulting engineer to the Chinese Government in the Grand Canal project; survey of the Greater New York water supply system in 1899-1900; consulting engineer on the Panama Canal 1907-1909; consultant in water supply investigation and construction for Los Angeles, San Francisco and Baltimore. In connection with sanitary and drainage problems he served as consultant to the Boston Metropolitan Park Commission.

He was noted for his work in fire-protection engineering and his work in this field brought him the presidency of an important group of mutual fire insurance companies. Later he served six such companies and his office was the largest of its kind, dealing with 4,000 factories carrying $2,000,000,000 of insurance coverage. Later he served also as Chairman of the National Advisory Committee on Aviation.

In 1922 he served as President of the American Society of Civil Engineers and in 1924 he established the $25,000 Freeman Fund in the Society, the income from which was to be used "in the aid and encouragement of young engineers," especially in research work in hydraulic science.

Recently a testimonial dinner, sponsored by the Providence Engineering Society, was given in honor of Mr. Freeman and it was President Hoover on that occasion who said:

"Mr. Freeman's great technical achievements in many lands were matched by his career of public service."

*The Shanghai Water Works Co. appears to be keeping step with progress as indicated by the fact that the company has just recently purchased an initial shipment of powdered activated carbon from an American Producer.—*Editor.*

CHARACTER OF SEWAGE IN THE SOUTHWEST*

By A. M. RAWN
Assistant Chief Engineer, Sanitary Districts of Los Angeles County, California

A. M. Rawn

THERE are so many definitions of "character" that I was somewhat at a loss to know just what was meant when I was asked to talk about "The Character of Sewage in the Southwest." Were I to accept some of Webster's definitions of "character," I could close these remarks immediately and dismiss the local product with the statement that it had none; was a base, untractable substance and that the less said about it the better. But unfortunately for me, as well as for you, I read too far in the list of definitions and came across the statement that "character" could be defined as "a description or detailed account of the qualities or peculiarities of a thing." Feeling that "quality," in the broad acceptance of the term, is a feature lacking in so gross a thing as sewage, I was enabled to narrow my vision to an examination of its peculiarities.

Perhaps these are best viewed by contrast. Unfortunately one cannot dismiss the subject by merely saying that "Sewage is Sewage" and end it there. A closer scrutiny may reveal many differences between the waste water or sewage of one community and that of even a near neighbor. The difference often is magnified if two areas far apart must be compared.

In pointing out the peculiarities of sewage in the Southwest, I must first of all call to your attention the character of its water content. Now water has character. It has quality. It has all of those qualifications of purity that commend themselves to us. Some may leave rings around the bath tub because of hardness and others may taste a little of chlorine on occasion, but we forgive these things and still think of water as something to be desired.

The sanitary engineer, in his more serious moments, is not so sanguine about what may appear to be a water of great purity, because he realizes that the water may, and nearly always does in this locality, conceal in its outward appearance of innocence, an unseen, and, so far as the waterworks engineer is concerned, harmless characteristic which if it finds the right company will fall into ways of physical turpitude and deal him more real trouble and concern than the waste materials conveyed to a sewer plant which he is trying, generally with indifferent success, to operate. The sulphate content is the offender. Sulphates are quite innocent until placed in company with anaerobes and deprived of water dissolved oxygen. Unfortunately, this unholy combination is arranged, or at least started, as soon as one turns the faucet of his lavatory or flushes a toilet, whereupon the once pure water assumes a sinister disposition and as though glorifying in its new-found badness proceeds to give off odors whcih will put to shame the fragrance of a male goat.

By contrast with most eastern and northern waters, the sulphate content of waters of this southwest bulks quite large. To be sure there are a number of water supply sources in other localities where sulphates are higher than usual and there are also water supplies hereabouts where they are quite low, but the general run of large supplies in the Southern California area carries a formidable amount averaging 50 to 70 parts per million. Nor will the situation be alleviated with the advent of

Interior View of 6 ft. 6 in.-Semi-Elliptical Section of Sanitary Sewer Showing Vitrified Clay Liner Blocks in Place. Joints Between Blocks Sealed with Sand-Sulphur Mixture Poured Hot. Los Angeles County Sewer

Colorado River water with its range of from 187 to 235 parts per million of sulphates. Doubtless there will be days to come, some years hence, following the flow of Colorado River water into this area, when a bounty will be placed upon the heads of all sanitary engineers who neglect to reckon with this sewage peculiarity.

The conspiracy formed by the water's mineral sulphate content, the southwest's moderate temperatures, the disposition of our citizenry to remove the locale of sewage concentration as far as possible from any future real estate subdivision, with resultant long collecting lines, these; with incidental flat grades and sewers built with a prayer that their capacity life will equal or exceed the retirement date of the last bond issued for their construction, all tend toward providing the multitudinous and prolific anaerobe with his favorite dish—the sulphate oxygen which he consumed to the accompaniment of a vast release of H_2S.

The net results of this organic attack are, first, the serious pollution of the atmosphere in the neighborhood of the sewer, to the great discomfort of the local residents and the ultimate replacement of the engineer of operation; second, the provisioning of another vast army of bacteria, whose favorite roosting place is on the walls

*Taken from a lecture delivered at the 1932 Institute of Government—Water Supply and Sanitation Division—University of Southern California. In an issue of WATER WORKS AND SEWERAGE in the near future an article will appear which discloses measures taken by Mr. Rawn's organization to overcome difficulties enumerated in this article.—EDITOR.

and crown of concrete sewers and whose mission in life appears to be the consummation of the sewer designer's downfall—these fellows take on their odoriferous food and after working it over proceed to expel it as sulphuric acid. This latter product being the sworn enemy of the calcium carbonates and hydroxides in concrete reduces them promptly to sulphates and thus changing the concrete's cement component to gypsum proceed to wreck the structure and furnish additional ammunition to their cousins who originally handed them their unsavory food.

There is a third result, which although not directly traceable to the mineral sulphates, can in some measure be laid at its door. By the time the sewage in one of our long, warm, slow flowing sanitary sewers has reached the plant or point of disposal, and the active bacteria have worked it over to their satisfaction, its sulphurous odors, discharged into the plant atmosphere, are accompanied with, to state it charitably, attendant difficulties. Could the sewers have been well ventilated during the passage en route, dissolved oxygen might have been maintained to a sufficient extent to hold in check the anaerobic activities, but proper ventilation in this case would mean the exhaustion of fumes along the line and it has been my experience that the venting out of sewer gases results in a complete and total misunderstanding with residents near the vent.

The net result of this restriction in proper ventilation is the receipt at the plant of a black, septic fluid teeming with a well-fed swarm of healthy enemies who flock in over the carefully nurtured oxidizing army, finally rout it completely and sail majestically through the final clarifiers into what the optimistic operator will still insist is a highly oxidized effluent.

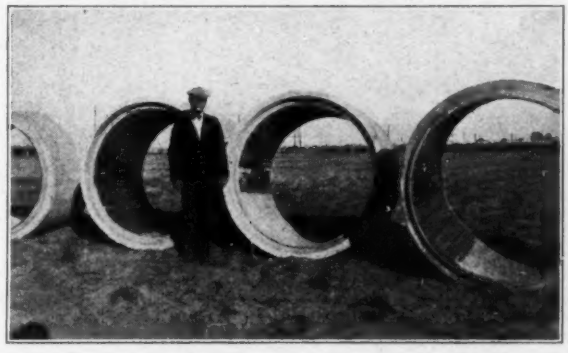
This mineral sulphate content then, as influenced by other southwest conditions, I list as peculiarity No. 1. Its trail is strewn with wreckage. Broken structures, disrupted plant operations, nuisances and complaints, and the ultimate confusion of a number of engineering aspirants abound as its effect. To be fair, however, and give the devil its due, it must be said that it has provided the clay pipe manufacturers with some very valuable sales propaganda and has been the inspiration for a long list of interesting, if sometimes bizarre, joint compounds. Perhaps its evils may be visualized when note is taken of a most unusual complaint which was recently directed to my attention, to the effect that nefarious odors originating at a local plant were so powerful and damaging as to have cracked the plaster in a living room of a residence some two miles distant.

My first reaction to the subject of this paper is sulphate; there are ways to check its ravages in the sewage. There are, in fact, methods which may be employed to completely eliminate its manifestations. The wise designer, in this locality, will do well to take heed of the presence of this apparently innocuous dissolved salt lest his lack of vision react to his great detriment if not his complete downfall as well as that of his structures.

So much for mineral sulphates. Next in order I would list the extent and diversity of relatively small industries. Looking through the Los Angeles Business and Manufacturing Director from Abdominal Supporters, the first, to Zippers, the last one, in addition to wondering why these two might not serve the same purpose, is quite impressed with the extent of industry hereabout. A more intimate knowledge of the industrials discloses them to be small for the most part, or at least not altogether large, and thereby hangs the tale.

The control of the sewer wastes from a large products manufacturing plant may many times be made the subject of an extensive, separate investigation, sometimes to the profit of the producer and resultant benefit to the sewer system. Possibly with large industrials connected and areas somewhat fixed in their outputs, the central sewer plant design may be built around such an investigation with some hope that its basic design features and considerations may not be changed for a number of years. This aspect is entirely changed when one views a large group of small industries in a growing locality. My experience leads me to the conclusion that the smaller the industry the less likely it is to be subjected to rigid control, that one of the concurrent features of such lack of control is the use of the sewers for getting rid of anything which may be in the way and might otherwise necessitate some investment for disposal.

To draw a specific picture, the population equivalent of small, for the most part, industries connected to the Sanitation District's sewer system is about 50,000 or 25 per cent of the entire sewage flow. This sewage is contributed by some 200 separate industrial plants, manufacturing food supplies; household necessities; iron, steel and semi-precious metal products; oils and soaps from minerals, vegetable products and fish; paints and gasoline, felt and leather products, as well as grease and



60-in Reinforced Concrete Sewer Pipe. Upper Two-thirds of Interior Lined with Clay Liners to Prevent Action of Destructive Decomposition Gases on Concrete

fertilizers from dead animals, packing house offal and chicken feathers. Fortunately, for the time being no impressive fruit canneries or milk products plants are hooked in, but time will doubtless remedy this oversight and add these commendable contributions. An occasional shot of waste from a milk products plant manufacturing casein would add much to the composite picture.

Taken together, in parts proportional to their daily quantities, these wastes may be readily cared for in an oxidizing plant, but to the embarrassment of the plant operator, there is no disposition on the part of the manufacturers to synchronize discharges, with the result that the sewage characteristics may, and often do, vary widely a number of times within an hour. The bacterium that can gracefully accommodate itself to a strong alkaline environment one moment and do equally fine work in an acid bath the next, has yet to be directed to my attention. Neither it nor its offspring live at my plant.

The difficulty lies, then, not so much in the composite sewage of all such industrials, but in the inability of plants, designed conservatively to cope with the ever-changing sewage characteristics. The regulation of such flows within reasonable limits, at the several sources, is an endless, if not impossible task, because in spite of threat of legal action, disconnection or

personal violence, the small manufacturer will take a chance and the oxidizing culture at the plant, to which the situation cannot be explained, turns up its toes in despair.

This second peculiarity is important. Plants all up and down the Coast have felt its influence. By-passed, untreated sewage is the result. A single small fruit cannery or milk products plant, encouraged by the overtures of an enthusiastic group of otherwise sagacious citizens, may locate in a small plant area. These are the common offenders. Their manufactured products may bring great revenue to the locality and add to the glories of California, but unless what comes out of the plant's back door is amply provided for, the enthusiasm will be short lived and the sanitary officials, though adept at explanations, find their alibis no defense against offensive odors and untreated sewage.

There is a third general difference which is evident

10-ft. 6-in. Semi-Elliptical Sanitary Sewer Section. Entire Arch Interior Lined with V. C. Liner Blocks. Joints between Blocks Sealed with Sand and Sulphur. Lining to Prevent Destructive Action of Decomposition Gases on Interior Concrete Surface. Los Angeles County Sewer.

in the local sewage. This one I list as the last of the three which I consider most important if one is to escape the pitfall of acceptance of general current design data, particularly in the treatment plant. This third one is strength—both per unit of flow and per capita.

Just why the Southwest sewage should be generally stronger than elsewhere is open to speculation. Perhaps we use more fruits and vegetables and in the preparation thereof convert our kitchens into miniature canneries. Maybe we just eat more of everything. Frankly, I believe that we eat less and throw more away. Possibly economists could find food for thought as well as much wasted food were they to subject the metropolitan sewage to a critical examination. Be that as it may, it develops that purely domestic sewage such as that of Pasadena, has an oxygen requirement of .21 lbs. per capita per day, while the combined industrial and domestic wastes of Los Angeles city sewage and that of the Los Angeles County Sanitation Districts have similar requirements of .26 lbs. and .272 lbs., respectively, the latter doubtless reflecting the effect of numerous small industries. To be sure there are again exceptions, but the comparison, particularly between the domestic Pasadena sewage and like flows in eastern cities is significant.

Per unit of flow, the oxygen requirements are compounded, for the reason that, while per capita daily discharges are low, per capita daily oxygen requirements are high—therefore the plant influents, subjected to this double concentration, show oxygen requirements ranging upwards from 225 parts per millian (5 day B. O. D.) for domestic sewage to 265 and 300 for those combined with industrial wastes.

The reflection of these high strengths in plant design should not be confusing. They simply mean a lower rate of through-put per unit of plant volume for at least those operations where preliminary sedimentation and bio-oxidation take place.

Sewage collection, treatment and disposal the world over is attended by a host of perplexing difficulties. The natural laws of gravity and change must, more often than not, be modified to suit specific needs. There are many sewage characteristics common to all localities. These form the broad general pattern of procedure, but the sanitary engineer who fails to exhaust the local irregularities and peculiarities of the area or sewage with which he is dealing must answer a double charge of neglect, first to his client and secondly to his advancing profession. Three of the local sewage idiosyncrasies have been enumerated herein; there are others, some more or less important, but these three represent to me the most striking contrast to the average picture. They are largely responsible for odors, structures failures, rapid changes in plant environment and plant volume control. They are all subject to preliminary analysis and the mischief which they may do to the unwary is readily thwarted, but they must first be recognized. Should one fail to take full cognizance of them in design or knowing of their presence, sacrifice their influence to expediency, he may live to see his professional hide nailed to the door of an abandoned structure of his own conception.

It would be unfair to dismiss this subject without mention of the sole virtue of the Southwest's sewage—its alkalinity. Probably many a shortcoming in plant design has been ironed out because of the ability of this buffer, alkalinity, to maintain a favorable environment for the oxidizing bacteria. Taken on the average, the pH index of nearly all the sewages hereabout will stand well above 7.0. The advantage of this is evidenced in increased plant capacity as to the work of the plant oxidizing culture, the possibility of longer detention periods in primary sludge thickeners and the control of an alkaline environment in sludge digestion. There are some disadvantages to it also, but enough of a bad name has been given to what we are attempting to cope with, so I'll list it as a virtue and leave the Southwest sewage with the solace of this doubtful merit.

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor

Physical Chemist, Bureau of Engineering, Chicago, Ill.

SPECIFICATIONS FOR POWDERED ACTIVATED CARBONS

PART II

Procedure for Making Quantitative Phenol Determinations

In WATER WORKS AND SEWERAGE for September, 1932, "Specifications for Powdered Activated Carbons" were suggested by Mr. Baylis. The recommended procedure to follow in determining the phenol adsorption capacity of various carbons was given. Lack of space prevented printing the laboratory method suggested for determining the residual phenol in test water samples which had been treated with activated carbons. It is presented in this issue as Part II of the general topic.—Editor.

IN connection with our work on activated carbon in Chicago it has been necessary to make a large number of phenol determinations. The most accurate test for phenol appears to be one developed by Gibbs[1]; using 2, 6-dibromoquinonechloroimide reagent to produce an indophenol, which has a blue color. This method was recently described by the writer in the Journal of the American Water Works Association.[2] It is expected that continued use of a procedure of this kind will result in slight modifications of the original procedure to make it more accurate and convenient. Oscar Gullans, Senior Sanitary Chemist of the Chicago Experimental Plant now uses a slightly modified procedure which will be outlined below. Samples of known phenol content are determined with such accuracy as to indicate that the test is perfectly reliable. The specifications for activated carbon require that no carbon be added to one of the samples containing phenol of a known quantity, and this serves as a check on the accuracy of the tests on the other samples.

The Hydrogen Ion Concentration Is an Important Factor in the Rate of Indophenol Formation.—Gibbs has shown that the pH of the solution is an important factor in the rate of indophenol formation. The most desirable pH appears to be about 9.8, and it should not vary from this figure more than 0.2 either way. That is, the pH should be not less than 9.6 and not more than 10.0. The pH of the samples and the standards for any one test should not vary more than 0.1 pH. This means that the solution must be highly buffered to obtain such uniformity. When the sample contains considerable CO_2 that can be driven off with the distillate the pH of the first portion of the solution collected may vary slightly from that of the others, if equal quantities of the buffer solution are added. This may be corrected by adding more buffer to the first portion of the distillate. Where there are a number of samples from the same source the excess of buffer solution needed can be determined occasionally and this will not make the phenol determination such a burdensome test.

In order to eliminate the necessity of adding more buffer to the first and second distillates, the addition of a small amount of phosphoric acid to the sample before beginning the distillation causes much of the CO_2 to go off into the air in the form of a gas when the water first begins to boil. Before starting the distillation the sample should be brought to a pH of approximately 6.5, by adding a dilute solution of phosphoric acid if necessary. At least 0.5 cc. of a 10 per cent solution of phosphoric should be added to each liter of solution even though the pH is reduced below 6.5. The acid appears to release the phenol from combination with the alkaline compounds of the water so that it will be distilled over more readily.

Reagents

1. *Alkaline Sodium Borate Buffer Solution.*—Dissolve 15 grams of anhydrous sodium tetraborate powder in 900 cc. of warm distilled water. Stir vigorously while the powder is being added to prevent lumping. Add 3.27 grams of sodium hydroxide in the form of a strong solution between 5 N and 10 N, and make up to one liter. Sufficient sodium hydroxide solution of known strength may be made up at one time to prepare several liters of buffer solution. Five cc. of the buffer solution added to 100 cc. of the special distilled water should produce a pH of about 9.8. If the pH varies more than 0.1 from this figure, the buffer solution should be corrected by increasing or decreasing the amount of sodium hydroxide added.

2. *Standard Buffer Solutions for pH of* 9.4 *to* 10.0.

—These solutions should be made according to Clark and Lubs as given in "The Determination of Hydrogen Ions" by W. Mansfield Clark (Williams and Wilkins Co., Baltimore). The following mixtures are used:

pH 9.4	50 cc. M/5 H_3BO_3, M/5 KCl	32.00 cc. M/5 NaOH
pH 9.6	50 cc. M/5 H_3BO_3, M/5 KCl	36.85 cc. M/5 NaOH
pH 9.8	50 cc. M/5 H_3BO_3, M/5 KCl	40.80 cc. M/5 NaOH
pH 10.0	50 cc. M/5 H_3BO_3, M/5 KCl	43.90 cc. M/5 NaOH

Dilute each of these mixtures to 200 cc.

3. *Thymol Phthalein Indicator.*—Dissolve 0.1 gram of the indicator in 250 cc. of 85 to 90 per cent ethyl alcohol. Use 0.5 cc. of the solution in 10 cc. of the buffer solution or the solution to be tested.

4. *2, 6-Dibromoquinonechloroimide Solution.*—a. Dissolve 0.1 gram of the powder in 25 cc. of 95 per cent ethyl alcohol and place in a small brown glass stoppered bottle. This is the stock solution, and it will keep for 3 or 4 days if placed in a cool dark place. To use, dilute 5 cc. of the alcoholic solution to 100 cc. with distilled water in a brown glass bottle. This solution must be used immediately as it is decomposed rapidly by sunlight and air.

b. If it is desired not to use an alcoholic solution, place about 0.04 gram of the powder in a mortar, add about 10 cc. of water, and grind until the powder is broken up very finely. Wash into a brown glass stoppered bottle and dilute to about 100 cc. Shake for about ten minutes and filter through paper. The solution decomposes rapidly and should not be kept for more than twenty minutes.

5. *Standard Phenol Solution.*—a. Dissolve 10 grams of pure phenol in 1,000 cc. of distilled water. Standardize against bromine or iodine. One cubic centimeter of this stock solution contains 10 milligrams of phenol. Dilute 1 cc. of the stock solution to 1,000 cc. with distilled water. One cubic centimeter of the weak solution contains 0.01 milligrams of phenol. The weak solution should be prepared every week as it does not maintain its strength for a very long period.

b. When the water to be tested for phenol contains the waste products from coke plants and perhaps a few other industries, there may be present, besides pure phenol, other phenolic compounds such as the cresols. In such cases the color developed by the 2,6-dibromoquinonechloroimide reagent may be bluish-purple and may not match exactly the color of the standards prepared from pure phenol. In such cases it is advisable to prepare a standard solution of phenol and cresol which will give a more accurate comparison. This may be done by mixing various proportions of pure phenol and cresol until the right shade of color is obtained, or if the pehnol in the water is from a by-product coke plant a sample of the ammonia still waste from coke plant may be obtained and used for preparing the standards.

The waste should contain at least 0.1 per cent of phenol. Measure 100 cc. of the phenol waste into a 500 cc. kjeldahl flask, and add 5 cc. of a 20 per cent solution of sodium hydroxide. Evaporate to 50 cc., add one gram of lead carbonate ($PbCO_3$) and boil one minute. Make the volume to 75 cc. with distilled water and add 25 grams of sodium bicarbonate and a few glass beads to prevent bumping. Distill over 50 cc. of the solution, cool, add 50 cc. of water and distill over another 50 cc. Cool, add 25 cc. of water and distill over another 50 cc., making a total volume of about 150 cc. of distillate, all of which may be collected in one flask. Dilute the distillate to 200 cc. and determine the phenol in a portion of the distillate by the hypobromite or iodine method. The balance of the solution may then be used for preparing standards.

6. *Distilled Water for Standards.*—Phenol free and chlorine free water is required for preparing the standards. If available, the water used for preparing the distilled water to be used in making the standards should have approximately the same mineral constituents as the sample to be tested. Assume that the water of a city supply is to be tested for phenol, it is best to prepare the distilled water from this supply. If there is phenol or chlorine present in the supply it may be removed by passing the water through a bed of activated carbon, or by adding an excess of powdered activated carbon and filtering.

The water before distilling should be brought to a pH of approximately 6.5, if it is above this figure, by the addition of phosphoric acid. It is advisable to add at least 0.5 cc. of a 10 per cent solution of 85 per cent phosphoric acid per liter of water even though the pH is reduced below 6.5. Use the same kind of distilling apparatus which is used for distilling the solution containing the phenol (a one-liter Maharg distilling apparatus frequently used for ammonia distillation is suitable). Place 800 cc. of the solution in the distilling flask and evaporate to about 200 cc. Repeat the procedure until the desired amount of distilled water is obtained.

7. *Phosphoric Acid Solution.*—Make a 10 per cent solution of 85 per cent phosphoric acid.

Phenol Standards

Use 100-cc. comparison tubes, preferably tubes having the 100-cc. mark about 25 cm. from the bottom. The longer tubes give a more accurate comparison when very small quantities of phenol are being tested. Add varying quantities of the weak phenol solution to the comparison tubes. Standards having 0.000, 0.001, 0.002, 0.004, 0.006, 0.008, 0.010, 0.0125, 0.015, 0.020, and 0.025 milligrams of phenol make a convenient range. It is not well to try to test a tube containing over 0.025 milligrams of phenol due to the difficulty in making accurate color comparisons. Dilute the tubes to the 100-cc. mark with phenol free distilled water which has been prepared in the manner specified under reagents. Add 5 cc. of the alkaline sodium borate buffer solution to each of the tubes. The 2,6-dibromoquinonechloroimide solution should be added when the distillates from the samples are ready for testing. The solution should be added to both the standards and the distillate portions at the same time. If the alcoholic solution of the reagent has been prepared according to 4-a, one and one-half cc. of the reagent should be added to each of the tubes, but if the water solution has been prepared according to 4-b, two cc. should be added to each tube.

Procedure for Making Phenol Determinations

If the sample contains more than 0.01 and less than 0.10 p.p.m. of phenol, place 800 cc. of the sample in an ammonia distilling apparatus having glass stopper and mercury seal. A Maharg distilling apparatus is suitable. Add approximately 1 cc. of the 10 per cent phosphoric acid solution to 800 cc. of the sample to be evaporated.

Collect the distillate in small flasks, each having a 100-cc. mark. The end of the condenser tube should project well into the flask so that there will be very little air contact. Distill at a rate of about 8 to 10 cc. per minute. Run the cooling water through the condenser fast enough to reduce the temperature of the distillate to at least room temperature.

Evaporate five 100 cc. portions of the sample and transfer the distillate to comparison tubes with the 100-cc. mark at the same height as that of the standards. Add 5 cc. of alkaline sodium borate solution to each of the

tubes, except that it may be known from previous tests that more than 5 cc. of the solution should be added to the first 100-cc. portion. Until the characteristics of the samples are known, 10-cc. portions should be withdrawn from all the tubes, both samples and standards, and pH tests made. This should be done before the 2,6-dibromoquinonechloroimide solution is added. Add 0.5 cc. of the thymol phthalein indicator solution to each of the 10-cc. portions and the same amount of indicator to 10-cc. portions of the standard buffer solutions. Determine the pH by comparing with the standard pH tubes. The thymol phthalein indicator produces a blue color if the pH is within the proper range, but the color soon fades and readings should be made immediately after adding the indicator. It is better to make readings on only 5 or 6 tubes at a time, making a new set of pH standards for each set of readings. Some have been successful in making fairly permanent standards by diluting "Long's Solution." Such standards will keep for one or two days if stored in the dark.

If the sample contains, or is suspected of containing more than 0.10 p.p.m. of phenol, place 500 cc. of the sample in the distilling flask and add approximately 0.7 cc. of the 10 per cent phosphoric acid solution. Distill over 400 cc. into a 500-cc. volumetric flask at a rate of 8 to 10 cc. per minute. Lower the flame of the burner to prevent cracking the flask and continue the distillation until approximately 450 cc. has been distilled over. Remove the burner and add 50 cc. of distilled water, and then continue the distillation until 500 cc. total has been collected in the volumetric flask. Add 100 cc. of the distillate without dilution to one comparison tube, make a dilution of 1 to 1 and add to another 100-cc. comparison tube, a dilution of 1 to 5, and a dilution of 1 to 10 to other tubes. In this way at least two of the tubes should come within the range of the standards. However, if the phenol is still too high greater dilutions can be made on the remaining portion of the distillate if it is stoppered and placed in a cool place until the outcome of the test is known. When the phenol is very high two hours' standing after the addition of the 2,6-dibromoquinonechloroimide solution develops enough color for one to determine if a greater dilution is necessary.

Phenol Determination.—After all the standards and the portions of the distillate have been buffered, add the 2,6-dibromoquinonechloroimide solution. If an alcoholic solution is prepared as specified in 4-a, add 1.5 cc. of the solution to each tube, and if a water solution is prepared as specified in 4-b, add 2.0 cc. of the solution to each tube. Wait at least 4 hours before making a comparison. The full color probably will not develop within this time and best results are obtained by allowing the tubes to stand over night. It is desirable to place a cover over the tubes while standing. Compare by using a piece of white paper under the tubes, a piece of white milk glass, or by the use of some color comparing instrument.

Recovery of Phenol by Distillation

Due to the alkalinity of the buffer solution which is added to the water to adjust the pH it is necessary to distill the samples when more than a few parts per million of calcium and magnesium compounds are present, otherwise precipitates will occur. Tests have been run in which known quantities of pure phenol were added to the Lake Michigan water. Using 800-cc. samples, the tests gave a phenol recovery of approximately 76.3 per cent when one-half of the solution has been distilled at a rate of 8 to 10 cc. per minute. The tests show that first 100-cc. portion will contain approximately 24.1 per cent of the total phenol which was in the sample, the second 100-cc. portion will contain approximately 20.7 per cent, the third portion approximately 17.4 per cent and the fourth portion approximately 14.1 per cent. This makes a total of 76.3 per cent of the phenol which goes over in the one-half portion of the sample evaporated. If the sum of the milligrams of phenol in the first 4 portions is multiplied by 1.60 the result is the parts per million of phenol present.

When a 500-cc. sample is used and 500 cc. are distilled over as recommended for samples high in phenol concentration, it can be assumed that almost 100 per cent of the phenol has been distilled over. Tests indicate that less than 1.0 per cent of the phenol remains in the still.

Method for Concentrating Phenols

When less than 0.005 p.p.m. of phenol are present it is desirable to concentrate the phenol by distillation, though lesser amounts may be approximated fairly closely. The concentrations may best be made by distilling 50 per cent of the solution from two or more portions of the sample. It has been shown that approximately 76 per cent of the phenol is recovered in the first 50 per cent of the distillate. Assume two 800-cc. portions of the sample evaporated one-half, and the two 400-cc. portions of the distillate combined to form another 800-cc. portion. This portion may then be distilled as previously described, collecting 100-cc. portions for testing. Should 0.020 p.p.m. of phenol represent the phenol in the concentrated sample; that is, in the combination of the two 50 per cent portions of the distillate, then the phenol in the original sample is

$$\frac{0.020 \div 76}{2} = \frac{0.020}{1.52} = 0.01316 \text{ p.p.m.}$$

This procedure may be carried any number of steps desired by dividing each previous step by 1.52. If 4 portions are concentrated to 2 portions, then the two concentrated to one 800-cc. portion, the original sample (assuming 0.020 p.p.m. of phenol in the last concentration) would have 0.0088 p.p.m. of phenol. Should 0.020 represent the phenol in the concentration of 8 portions of the original sample the original sample would have 0.0058 p.p.m. of phenol. This is about as far as it is practical to concentrate. With the minimum amount that can be determined accurately in the concentrated sample it is possible to determine about 1 part per billion or 0.001 p.p.m. by this procedure of concentrating.

Theriault[3] gives another method of concentrating phenols when the quantity is low. This method is more simple than the one just given. Take a suitable quantity of the sample and make it definitely alkaline by adding 5 cc. of 12 M sodium hydroxide (480 grams per liter). Boil down rapidly to a volume of about 80 cc. The sample is then acidified with 1:1 or 6 M hydrochloric acid, avoiding a great excess. After making up to 100 cc. the neutralized sample is distilled until 90 cc. of distillate have gone over. After adjusting to pH of 9.4 the entire distillate or an aliquot portion is tested for phenol. Theriault does not state, but presumably a large amount of the sample may be evaporated by repeatedly adding more to the beaker as the water is boiled off. In this procedure the phenol is held back as a sodium phenolate until the desired concentration is made, then the solution is neutralized and the phenol driven over with the distillate. Theriault buffered his solution to a pH of 9.4, whereas Gibbs' work indicated that a pH between 9.6 and 10.0 was desirable. The writer prefers to use a pH of about 9.8.

Storing Samples.—The phenol in a very weak phenol solution decomposes upon standing. If possible, the sample should be tested within about 4 hours after collection, or within 4 hours after the stirring has been com-

pleted in making phenol absorption tests on activated carbon. Some have made attempts to preserve the samples. It has not been necessary to store samples in our laboratory, consequently we have not made tests on how to preserve the phenol in samples. The laboratories of the Chicago Health Department report very good results by adding about 5 cc. of a normal solution of sodium hydroxide per gallon of the sample. When the sample is ready to be tested the pH is adjusted to between 6.0 and 6.5 with phosphoric acid.

Credit must be given the chemical laboratory of the Chicago Health Department for developing the use of phosphoric acid to produce more uniform phenol recovery by distillation.

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Disposal of Sludge from Final Settling Tanks

By JOHN R. DOWNES

Supervising Engineer,
Plainfield Joint Sewage Disposal Plant,
Bound Brook, N. J.

IN THE original design of the Plainfield Joint Sewage Works (1916) the final settling, or humus tank, beyond the sprinkling filters, was built as an Imhoff tank but with very little capacity in the sludge compartment. It was proposed to pump the sludge frequently to the sludge compartment of the primary Imhoff tanks for digestion. Evidently the thought was that the slopping baffles in Imhoff tanks would effectively separate the humus sludge from the flowing sewage and thus prevent recontamination of the liquid.

The scheme proved impracticable for three reasons: (1) the baffles did not provide effective separation; (2) the centrifugal pump was not adapted to this work; (3) the digestion compartments of the primary tanks did not have sufficient capacity to care for the humus sludge.

In 1923 a separate digestion tank was built to care for this final tank sludge (humus), and about 5,000 sq. ft. of drying bed area was provided to receive the digested material. An additional 4,500 sq. ft. was so situated as to be available for this purpose provided that the ripe sludge was pumped to it. This plan proved practicable but the capacity of the digestor was small and ground water conditions discouraged further construction in the vicinity of the final settling tank.

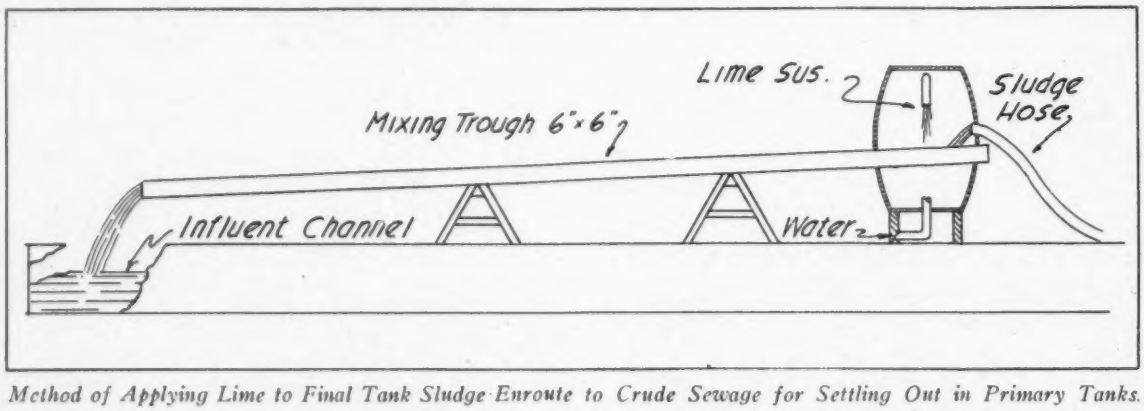
The success of the separate digestion tank, however, lead to investigation of the possibilities of separate sludge digestion for both primary and secondary tank sludge in heated and covered tanks. Experiments conducted during 1925 and 1926, in an earth tank of 16,000 cu. ft. capacity, provided with floating covers and heating arrangements, lead to the construction of two 20,000 cu. ft. concrete tanks with similar appurtenances. These were put into operation on Oct. 8, 1926, the first heated digestion tanks in this country.

The final tank sludge was too watery to be admitted directly to the digestors and resedimentation in the primary tanks by returning this sludge to the inlet channels was not satisfactory. The very light and finely divided solids failed to settle out effectively.

Coagulation or precipitation of these solids with chemicals seemed to be the next logical step. Alum coagulated the solids satisfactorily but caused them to float rather than settle and in addition reduced the pH. of the sludge when our aim was to maintain it above the neutral point. Lime, on the other hand, caused the solids to settle and raised the pH thus fulfilling our requirements in securing a good primary tank effluent, and an alkaline sludge.

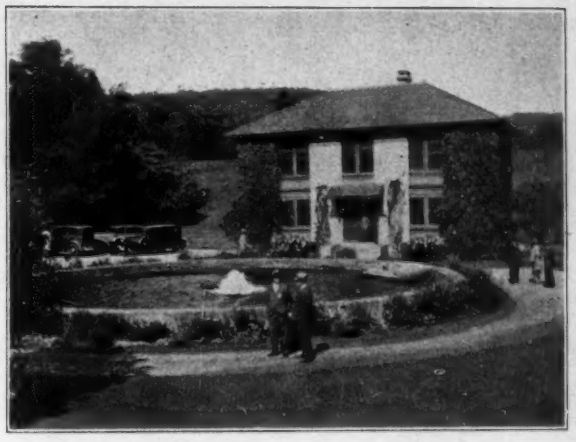
A Marlow 4-in. plunger pump with ball valves was installed to replace the centrifugal pump. This pump forces the humus tank sludge through some 400 ft. of 6-in. C. I. pipe and 75 ft. of fire hose against a total head of 56 ft. The hose discharges into a slopping wooden trough 20 ft. long which in turn discharges into the primary tank inlet channel.

The velocity of flow in the wooden trough provides the necessary agitation for thorough mixing of the lime which is admitted to the sludge just as the latter leaves the hose. The lime may be applied in a variety of ways of which the local method is, perhaps, the most simple. A 50 gal. barrel is provided with a hose connection at the bottom and a ¾-in. overflow pipe near the top which discharges into the wooden trough. Lime is put into the barrel and stirred and is then carried through the overflow pipe in suspension by a continuous small stream of water entering through the bottom hose connection. An obvious improvement would be an agitating paddle operated by a small motor to keep the lime in suspension. Locally the lime is stirred occasionally by hand. A dry feed machine would obviously serve admirably, but the apparatus described will provide an inexpensive method of experimenting with the chemical precipitation of final tank sludge where it is desired to return it to primary tanks without deleteriously affecting the effluent of the latter. Big cut and try procedure the most effective and economical lime dosage can be arrived at.



Method of Applying Lime to Final Tank Sludge Enroute to Crude Sewage for Settling Out in Primary Tanks.

CONVENTION OF NEW ENGLAND WATER WORKS ASSOCIATION



Laboratories and Offices, West Parish Filters, Springfield, Mass.

THE 51st Annual Convention of the New England Water Works Association was held at the Hotel Kimball in Springfield, Mass., on September 27th to 30th inclusive. Upon invitation, the New York Section of the American Water Works Association met jointly with the New England Association, swelling the registration to a few less than 600 and total attendance well above that number. Manufacturers exhibiting numbered but one or two less than 50.

If this writer is a judge, the 51st Convention of the N. E. W. W. A. was in every respect an excellent one from all angles—program, exhibits of waterworks equipment and materials, and entertainment. For the latter, credit is due our old standby—Burt. B. Hodgman, assisted by John S. Ward. No few comments were made concerning the excellence of program as arranged by E. Sherman Chase, chairman of the Program Committee, and First Vice President of the Association.

The City of Springfield entertained members and guests by serving luncheon at Cobble Mountain Dam which has but recently been completed by the Springfield Water Department and serves to impound water for domestic consumption and for developing power—all water over and above Springfield's requirements being sold to a power company for generating electric current.

The Cobble Mountain project was conceived by the late Allen Hazen, the location was picked by him and the dam was designed in his office. Cobble Mountain Dam has the distinction of being the highest hydraulic earth-fill type of dam in the world and during its construction many new principles and standards in earth-fill dam construction were developed. The dam was constructed under strict laboratory control and records are complete in every respect. That the depth of water behind the dam will be 222 feet when the reservoir is filled is impressive.

Medal Awarded Thaddeus Merriman

The convention was opened by President George C. Brehm introducing the Hon. Dwight R. Winter, Mayor of Springfield, who delivered an address of welcome. James J. Shea, Water Commissioner of Springfield also added a word of welcome.

The Dexter Brackett Memorial Medal was awarded Thaddeus Merriman, Chief Engineer, Board of Water Supply of New York City, who in 1931 presented before the Association the most outstanding paper on water supply that has appeared in years—"The Law of Interstate Waters and its Application to the Case of the Delaware River.* Mr. Merriman in acknowledging receipt of the award said, that he liked to think of the award received as a recognition of an obligaion discharged for the good of the water works profession and felt it a privilege to have served the Association. Waldo Smith, Consulting Engineer, Board of Water Supply, New York City, in introducing Mr. Merriman said that it was conceded that Mr. Merriman's paper was of a calibre that would be referred to in years to come as a standard for similar cases.

*Printed with discussions in the *Journal of the New England Water Works Association*, Vol. 45, pp. 199-311, September, 1931.

Committee Reports

E. Sherman Chase, reported for the Committee on a System of Sanitary Scoring of Water Supplies. He said, that committees from other associations were cooperating with them but that to date the American Water Works Association and likewise the American Public Health Association had as yet been reticent about adopting the system proposed. Mr. Chase also reported that the Committee on Disinfection of Water Mains had continued its activity. Work of compiling available information on methods and processes was under way.

Thaddeus Merriman

George C. Brehm, Retiring President.

Wm. R. Conard reported for the Committee on Specifications for Cast Iron Pipe and Fittings, that tests covering specifications were being prepared.

Gordon M. Fair reported for the Committee on Water Works Education. He referred to the first New England Water Works School, held in June, which had been attended by 22 men. In the future the school would probably be held in February and at various locations offering the best advantages for instruction.

President's Address

Somewhat out of the ordinary the customary address by the President was made the closing event of the Convention. President Brehm, who is Superintendent of Water Works at Waltham, Mass., said that it was to be deplored that Superintendents did not prepare papers for

presentation before the Association of the calibre to win the Dexter Brackett medal award and that he hoped that Superintendents would make efforts to win the award in future years. He felt that this had been a most trying year on Water Works Managers and Superintendents who had had to fight to prevent diversion of water works funds to other uses by cities. It was imperative that water works men stand their ground in a determined fight against "penny-wise but pound foolish" practices of economy in water works operation and maintenance, lest situations of real danger and seriousness result. The reduction of personnel in Operating and Maintenance Divisions would prove serious should emergencies arise. He urged the Association's Committee to Prevent Diversion of Funds to double their efforts at this time. He felt that the members of the Association should endeavor to interest a greater number of Mayors, City Managers and Commissioners in the Association's meetings and activities in order that a better understanding and appreciation of water-works practices might be gained by such officials. He recommended an increase in personnel of the Committee on Membership and selection of real "go-getters" to serve in building up the Association and increasing interest therein.*

Executive Committee Calls the R. F. C. to Account

Disappointment, bordering on disgust, led the Executive Committee of the Association and its running mate, the Water Works Manufacturers' Association, to jointly draw up a communication which the Association unanimously approved for transmittal to the Reconstruction Finance Corporation but only after some discussion indicating that the thoughts behind the letter were really stronger than those expressed.

The communication will say in substance that the two Associations are considerably concerned over the disappointing progress of the R. F. C. in the matter of approving loans to municipalities for water works betterments and new projects. That every effort be made to speed up this phase of the Corporation's work and likewise that municipalities speed the preparation of plans and filing of applications for water supply development loans. Much valuable time having already been lost it will be difficult to get work under way in time to prove of the value intended and, therefore, it will be essential to act quickly if anything of real value is to result during the critical Winter approaching.

Stephen H. Taylor, Superintendent Water Works, New Bedford, Mass., reported that the amount of "red-tape" and time involved in application for a R. F. C. loan had caused the officials of his city to prefer borrowing from the local banks instead of the R. F. C.

New Officers 1932-33

President—R. H. Ellis, Commissioner Water Works, Newton, Mass.

Vice-President—E. Sherman Chase, Consulting Engineer, Boston, Mass.

Vice-President—H. W. King, Superintendent Water Works, Springfield, Mass.

Directors—Roger W. Esty, Superintendent Water Works, Danvers, Mass; H. U. Fuller, Chief Engineer, Portland Water District, Portland, Maine; W. J. Scott, Chief Engineer, Connecticut State Department Health.

Reelected were: Frank J. Gifford, Secretary; Albert L. Sawyer, Treasurer.

Technical Sessions

The first afternoon was devoted to a series of papers descriptive of the Springfield Water Works in which E. E. Lochridge, Chief Engineer, Springfield Water Department, opened the symposium by general remarks and thereafter presented the several speakers in order.

"Description of the Springfield Water Works"—E. E. Lochridge.

Mr. Lochridge said, that early history indicated the incorporation of the Springfield Aqueduct in 1798 which supplied spring water to the village. Since 1910 the city has drawn on Little River for its water supply, slow sand filtration having been installed as designed by the late Allen Hazen and his associate C. M. Everett. Mr. Lochridge said, that the most recent developments had been the Cobble Mountain Reservoir and Dam construction, additional filtration capacity and the increased filtered water service-reservoir and mains capacity. The unique feature of the Cobble Mountain project had been the available maximum head of 456 feet of water which would produce electric power before being delivered to the filtration plant at which more power was being extracted from the same water enroute through the purification works. The Cobble Mountain reservoir had been made of sufficient size to store water over and above the domestic supply requirements and the surplus water would be sold to the Turner's Falls Power and Electric Company for their use in power development during low stream flow periods when otherwise steam stations would have to be pressed into heavier service. The reservoir and dam site had been selected with that in mind and the income from sale of power water would amount to $270,000 per year. The revenue received by the Water Department will carry and retire the construction cost of the new developments during a period of 30 years, or at the rate of 5.8 per cent interest and retirement charge on the 30 year 4 per cent bonds. The improvements would yield a minimum of 55 m.g.d. and an average of 62 m.g.d. The details of the developments, he wished to leave to the speakers to follow. He introduced H. H. Hatch, Division Engineer.

E. E. Lockridge, Chief Engineer, Water Supply, Springfield, Mass.

H. H. Hatch, Division Engineer, Springfield Water Department.

"The Cobble Mountain Dam"—H. H. Hatch, Division Engineer, Springfield Water Department.

Describing "the highest hydraulic earth-fill dam in the world,"* Mr. Hatch, who had been in charge of the construction of Cobble Mountain Dam (1927-1932), said that during its building much value had been learned in respect to control of the characteristics of the all important core of earth-fill dams and the regulation of the "beaches" on each side of the core. The dam, he said, contained 1.8 million cubic yards of material, 300,000 yards being rock, 1.4 million earth and that 5,270 yards of concrete and grout had been used in foundation and

*In the report of Secretary Gifford it was disclosed that the Association had suffered a net loss of but 7 members during the year.—*Editor.*

*Front Cover illustration shows the completed dam with reservoir empty.

cut off walls—of which there are two in the dam. The width of the dam at its base was 1510 feet and being built in a gorge had a length at bottom of but 62 feet as compared with 730 feet at the top. Its height at center is 243 feet about the original river bed and 263 feet above the foundation in solid rock. The reservoir, covering an area of 1,134 acres would contain 22.8 billion gallons when full.

The spillway was constructed through solid rock for 735 ft. and consists of an open cut 50 ft. wide and 55 ft. deep. The crest of the spillway is 135 ft. wide, forming a "bellmouth" which narrows to the 50-ft. width within 200 ft. The terminus of the spillway is 265 ft. above the original stream bed and about 2,900 ft. downstream from the dam. In designing the spillway three models (one fiftieth actual size) had been constructed for study and experimentation before the present design was perfected. A concrete toe wall on the downstream end of the dam consists of a 100-ft. radius concrete arch dam 50 ft. in height with bottom width of 30 ft. tapering to 14 ft. at the top.

For the hydraulic cutting operations 5-in. giants had been successfully employed. The flow in the "mud lines" (20-in. diameter steel pipes) contained 7.5 per cent solid materials, requiring a minimum grade of 4 per cent to prevent clogging. The grading of the size of solids reaching the outside and interior of the core had been secured by a series of regulating baffle logs or boards arranged on the two "beaches"—the latter having been brought up evenly on each side. Placing 10,000 yd. of fill per day required 25 m.g.d. water flow. Being necessary to conserve water, the operations had been on a closed circuit as far as practicable. All materials up to 8 in. in diameter had been handled through the pipe lines, the life of the pipe varying from 100,000 to 2,000,000 yards handled. When filling materials had to be brought dry to the dam site these were sluiced through specially designed "dissolving boxes" serving to grade the material preliminary to discharge to the beaches. To this piece of equipment and its operation considerable study had been given in order to prevent organic matter (roots, etc.) from entering the core of the dam. When nearing the top of the dam, dry materials had to be dumped directly into the core pool from an industrial railway constructed on each beach.

Mr. Hatch stressed the importance of control of the core fill and pointed out that seepage passes through all earth fill dams but that such leakage could be sharply curtailed by regulating the fineness and grading of the core materials—the finer material reaching the interior of the core. Fines deposited on the outside of the core would create "lubricating planes" resulting in serious danger of slippage.

"The West Parish Filtration Plant"—Herbert F. Salmond, Chemist, Springfield Water Department.

The Springfield plant of the low sand type is located 14 miles from town, consists of 10 filters (6.25 acres) of which 4 units are new. Preceding the filters is a 42 m.g.d. coagulation basin equipped with automatically controlled inlet gates. Alum is added for coagulation during a part of each year when color in the Little River water exceeds 25 parts. Power is generated 24 hours per day by the water leaving the coagulation basin enroute to the filters. Aeration is secured through two circular fountains. The filter sand (42 in. depth) is of effective size 0.3 m.m. and uniformity coefficient is 2.3. Mr. Salmond said, that the filtration rate employed was 3 m.g.d. per acre, filters are scraped upon showing a 6-ft. head loss with one raking given between scrapings. At each scraping 1½ in. of surface sand is removed. When the sand depth has been thus reduced to 20 in. all sand is removed and washed before being returned as a precaution against under surface clogging of beds. Consumption of wash water had been 0.53 per cent and average service of filters between scrapings had yielded 187 million gallons per acre. Average cost of operation had been $6.40 per m.g. and the plant output had averaged about 17 m.g.d. in 1931. Interest and depreciation would raise th ecost to $11.22 per m.g.

Interestingly, a scheme of alum overdosage of the water entering the coagulation basin during 6 to 12 hours and allowing the untreated water to mix with the over-treated water during the remainder of each 24 hours, had proven the most satisfactory and economical means of reducing color. The average alum dosage had been 0.397 grains per gallon to reduce the color from 38.6 to 13.8 p.p.m. in 1931. That had amounted to roughly 2.3 lbs. of alum per m.g. for each part of color removed by coagulant and filters. The color of the raw water had averaged 38.6 p.p.m. during 1931 with 13.8 p.p.m. remaining in the effluent. Average turbidity had been 4.5 p.p.m., hardness 13.0, and alkalinity but 7.8 p.p.m. in the river water. B. Coli had been found in the river water but 16.5 per cent of the time and during the 23 years of plant operation has never been found in 1 c.c. samples of the filtered water. Mr. Salmond's paper contains data covering 21 years of filter plant operation at Springfield.

Banquet at 51st Annual Convention of New England Water Works Association

"The Cobble Mountain Power Development"—Herbert A. Moody, Hydraulic Engineer, Turner's Falls Power and Electric Company.

Mr. Moody reviewed the mutual advantages to the Turner's Falls Company and the City of Springfield which justified the larger dam required to store power water leased to his company. An agreement between the city and the company, whereby a maximum allowed draw-down of the reservoir (not to diminish the storage below stipulated levels for each month) had been reached. This allowed a minimum draught sufficient for 23,000 kilowatt output by the power station at the possible minimum head of 330 ft. for the driest year for which records are available. The chief value of the Cobble Mountain power would be found in dry weather when "stream-run" stations would be operating at a low output and deficiencies would otherwise have to be made up in steam operated stations to meet peak loads. The lease had been justified based upon that advantage alone if nothing more.

One or two unusual features of the project had been the penstock which had been electric welded in 30-ft. lengths and the latter being electric welded in place from the inside. The other was the diffusion of air into the large stand pipe or surge tower on the penstock in order to prevent freezing. A particularly important item had been the slow closing governor-controlled gates which admit water from the penstock through the wheels of the generators. Seven seconds had proven the most practical time for complete closing as against the two seconds in common practice. Water hammer (surge) had been reduced 200 ft. as a result. Power was to be generated at 6900 volts and stepped up to 69,000 volts at the station.

Roger W. Esty, Superintendent Water Works, Danvers, Mass., Newly Elected Director of the Association.

W. A. Gentner, Hartford, Conn.

Professor H. K. Barrows of the Massachusetts Institute of Technology, said, that the capacity of the Cobble Mountain plant had been the highest per square mile of drainage area yet known and about 12 times the average river plant capacity. The mean run off would be about 1.96 second ft. per square mile of drainage area, but the Cobble Mountain project would yield about 24 second ft. available per square mile. He thought that other New England cities might profit by the scheme of using surplus storage for power development.

Mr. Lochridge, in reply to a question as to the possibility that chemical treatment of the water could later be dispensed with, said that since drawing on storage in Cobble Mountain Reservoir the temperature of the water had been lower, color had not changed to any noticeable degree, but was expected to improve. He said that not more than 1 per cent of the area of the reservoir to be flooded had been stripped. The large coagulating basin at the filter plant had been cleaned but twice in 23 years but that arrangements existed for by passing it whenever cleaning was necessary.

Superintendents' Day

Superintendents' Day was devoted to general discussions dealing with meters, water main cleaning and water consumption. Mr. Owen E. Parks, presided during the forenoon session. The first paper was that presented by W. A. Gentner, of Hartford.

"Domestic Flow as Affecting Meter Registration and Water Revenue"—Harold W. Griswold, Deputy Manager and W. A. Gentner, Office Engineer, Water Bureau, Hartford, Conn.

Mr. Gentner said that since 1904 Hartford had been completely metered and the investment in meters had reached $32.00 per meter as the average cost In testing endurance and accuracy of meters extended tests had been run on a series of meters through which continuous and intermittent streams had been passed to a total volume of 725,000 cu. ft. For the intermittent flows a Sloane flushometer valve had been successfully employed at the rate of 20 gallons per minute and in all requiring 1730 valve operations. Results of the tests had shown the extremely long life to be expected of meters as now manufactured. In Hartford the revenue from 10,000 odd ¾-in. meters had been 33 per cent of the total and from 12,707 meters of ⅝-in. size 20 per cent of the revenue was derived. Only 10 per cent came from the 200 meters of 1-in. size and larger.

To determine what quantity of total water consumed had not been registered by meters, tests had been made in shop and field. From 7 to 12 per cent had not been recorded and represented $2.30 lost revenue per meter which amounted to $11,000 income loss per year at Hartford. They had found that 35 to 45 gallons of water per capita constituted the average domestic consumption. From 38 to 70 per cent of the time the draught through household meters had been found to be less than a 2-gallon rate per minute. To most accurately check meter registration it is proposed to use 1 cu. ft. capacity gasoline test cans in field tests.

R. H. Ellis, Commissioner, Newton, Mass., President Elect.

D. A. Heffernan, Superintendent Water Works, Newton, Mass.

In repairing meters they had found it most desirable to return the units to the manufacturers for installing fitted parts. Repaired meters must meet the following required accuracies:

1/32 in. stream—meter must register.
1/16 in. stream—93 per cent or more of the water must be registered.
1/4 in. stream—98 to 102 per cent accuracy must be had.
Full flow—102 per cent accuracy must be had.

To date repairs had proven that $5,000 per year could be recovered. Records had shown that 70 per cent of the meters, five or more years old, had needed replacement of the disc and chamber.

Reeves J. Newsom, Vice-President Community Water Service System said, that the Hartford experiences had confirmed the readiness with which the following requirements of accuracy as set up by his company be met:

	New Meters	*Repaired Meters*
1/32-in. stream	94% or more	Must register
2 gallons per minute	98 to 101%	97 to 100%

R. K. Blanchard, Vice-President of the Neptune Meter Company, said, that manufacturers have tried to encourage cooperation in testing repaired meters. He was of the opinion that loss of registration or low flows

Luncheon at Cobble Mountain Dam as Guests of the Springfield Water Department.

was not made up by the slight over-registration during high flows. He thought well of the application of the calibrated test can for making field tests.

J. Herman Smith, of the Hersey Meter Company, felt that the treatment given meters in the past had not been conducive to maintained accuracy and proper meter functioning. He urged the bettering of meter shop conditions and employment of capable and interested men to repair and test meters. The new meter shop at Newton, Mass., was an example of what could be accomplished in this direction. His opinion was that lack of meters on public supplies and fire mains was of more consequence than under-registration of minor flows through domestic meters.

Chas. W. Sherman, of Metcalf and Eddy Engineers, was surprised to find that many municipalities, though completely metered, failed to check up total water entering the system against that registered by the meters. He felt that increased frequency of meter testing had resulted in an increased percentage of water accounted for.

J. W. Ackerman, City Manager, Fall River, Mass., reported that 80 per cent of the water pumped could be accounted for in Fall River. Their meter testing and repair operations had improved following a course of training which he had arranged for by sending one of his best repair men to one of the meter factories. Income from water sale had increased above that of a year ago and he had found metering of fire supply lines the best income producer he had yet discovered.

D. H. Heffernan, of Newton, Mass., spoke on the matter of charges for fire hydrant rental as being a practical means of raising the income of the water department. He said that his department could account for 100 per cent of the water.

David E. Moulton, President, Portland Water District, Portland, Me., said that he questioned the practical side of expenditures for meter testing and repairing if the meters were approximately accurate and thought the raising of rates to compensate for unregistered water was the more satisfactory solution.

Geo. F. Merril, Superintendent Water Works, Ware, Mass., was of a like opinion. He felt that silt caused faulty registration.

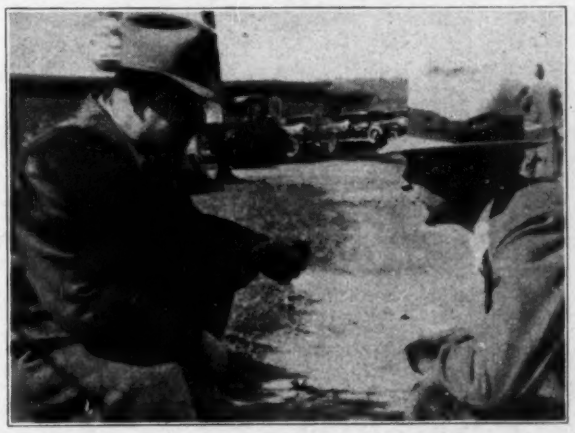
To a question from the floor, Mr. Gentner replied that one man could comfortably repair one meter per hour.

Roger W. Esty, Superintendent Water Works, Danvers, Mass., said that testing large meters at Danvers had resulted in an $1800 income being increased to $4,200 from one meter alone. They had arranged for simplified testing of all large meters 3 times yearly. At Danvers 73 per cent of the water is metered. Mr. Esty related his experiences in dealing with oversized meters where smaller meters would prove more economical and less likely to pass unregistered water. He was of the opinion that the city should own and control the meters and pay for them by a service charge such as charged by his department viz.: $6.00 per year.

F. H. Kingsbury, Engineer, Massachusetts State Department of Health, in reply to a question, said that about 75 per cent of the Massachusetts cities report figures to them disclosing unaccounted for water. He spoke of valve regulation as a means of reducing pressure on systems at night and thus reducing water waste and leakage. Properly conducted, the scheme had been used effectively where water shortage had approached the danger point in storage depletion. He had observed a tendency of manufacturing plants to draw more heavily of late on municipal supplies than previously had been the case.

"Experiences with Water Main Cleaning"—Arthur T. Clark, Division Engineer, Greenwich Water Company, Greenwich, Conn.

Mr. Clark, called attention to the value of systematic cleaning of water mains and the use of chemical treatment of the water to subdue the rapidity of tuberculation. In certain cases the practical elimination of further tuberculation of the interior mains had resulted from chemical treatment. He said that it was surprising to observe the material lowering of the carrying capacity of large mains which very moderate tuberculation had been responsible for. At Lexington, Ky., ⅛ to 3/16 in. tubercles had reduced the carrying capacity coefficient to 90 and at Greensburg, Penn., somewhat more pronounced corrosion had resulted in a coefficient of 63.5 prior to cleaning. A 16-in. main of the New Rochelle Water Company (N. Y.) had been found to have been reduced



J. W. Holden, Chief Engineer Board of Water Supply of New Britain, Conn., (Right) Is Telling One to Chester M. Everett. Mr. Everett Is Consulting Engineer to the Springfield Water Department and a Former Partner of the Late Allen Hazen.

in capacity to a 12-in. main (C=100) or a 10-in. main (C=120) by the presence of tubercles ¾ in. high but oval in shape. The shape of tubercles seemed to have an important bearing on the problem and the appearanee

and height of tubercles might be deceiving. To properly evaluate the loss of main capacity, records of flows and pressures along the line must be taken over a definite period rather than depending upon spotty observations.

Mr. Clark described the construction of cleaning pits installed on a 7-mile 16-in. main of the New Rochelle Water Company, in which an 8-ft. section of the pipe was held in place by two Victaulic couplings. Removal of two coupling bolts and rolling aside the section was all that was required in order to insert or withdraw the main cleaning machine. This 7-mile section had been cleaned periodically for 4 years without injury to the

H. M. King, Superintendent, Springfield, Mass.

Frank J. Gifford, Dedham, Mass., Secretary.

original pipe coating and the pipe coefficient thus kept at C=120. After cleaning the first time, the pumping head had been reduced by 100 ft. The entire cleaning job covering the 7 miles required 5 hours from cutting main out of service to replacement in service.

Concerning economy of cleaning, Mr. Clark had had experience with a 6-in. main, wherein cleaning had saved $4,800 per year in the cost of pumping a 3 m.g. per day.

In reply to a question, Mr. Clark said, that the 16-in. New Rochelle main was cleaned whenever the coefficient

E. C. Cotton, Superintendent Filters, J. B. Porter, Assistant Chief Engineer, Springfield Water Department.

dropped to C=100. At present two cleanings per year are required.

P. S. Wilson, Consultant in Water Works Management, Glen Ridge, N. J., cited a case at Washington, Penn., during his previous connection with the Community Water Service Company, wherein the added friction through a 10-in. force main had thrown the pumps off of their efficiency and thereby added abnormally to the pumping cost. Main cleanings at intervals of 3 months and pumping during "off-peak" hours had proven a worth while economy. The cleaning machine had been rented, the operation each time requiring but 3 hours.

William R. Conard, Consulting Engineer, Burlington, N. J., cited four cases to support the value of systematic water main cleaning operations. One was a case of removal of manganese depositions which had increased carrying capacity of the main by 40 per cent. In one instance a clay-like deposit was removed from a force main and that cleaning had increased delivery capacity by 45 per cent and reduced the pumping head of 137 lbs. and delivery of 600,000 g.p.d. to a head of 95 lbs. and delivery of 820,000 g.p.d. One long gravity main had been cleaned with a resulting appreciable increase in delivery.

Timothy W. Good, Superintendent of Water Department, Cambridge, Mass., enthusiastically commended the practice of water main cleaning. At Cambridge they had cleaned 32 miles of pipe line. Cleaning 9000 ft. of 30-in. main to the filtration plant had raised its delivering capacity from 12.5 m.g.d. to 16 m.g.d. Inspection had shown no tuberculation of a line which had been cleaned in 1928. Following cleaning, the water had been turbid somewhat for 12 hours only. Cambridge had cleaned the 32 miles of mains at a cost of $45,800 and as an economical measure he highly commended it.

Mr. Luby reported experiences at Troy, N. Y., wherein a 33,000-ft. length of 16-in. main had been cleaned in 1929 to return it to its original capacity of 4.5 m.g.d from the 3.25 m.g.d. which it had dropped to.

C. A. Leonard, Kenwood, N. Y., raised a question as to what precautions were taken to control secondary corrosion of cleaned mains. Mr. Clark answered by saying that on the Pocantico Main line was applied to the water to insure pH values between 8 and 9. That had produced a thin deposition of protective coating on the interior of the main but strangely enough, he had observed that the tubercles appeared to be growing from beneath although covered over with the film which the pH correction had caused to be deposited.

"Water Consumption in American Cities"—A. Prescott Folwell, Editor, Public Works, New York, N. Y.

To a questionnaire sent out by Mr. Folwell, 361 cities replying had supplied records of water flows and consumption—75 per cent being from meter records and 18 per cent from pumping records. From these replies data had been compiled which revealed the months of maximum water consumption in 80 per cent of the cities reporting, to be July or August, the quantity being 1.34 times the average monthly consumption. Maximum daily per capita consumption appeared to be 1.53 times the average per capita daily consumption. Based on population figures for 1930 census, the average per capita consumption in large cities had been 117 gallons per day or if based upon number of consumers reported was but 109 gallons. The maximum consumption per capita for any given hour seemed to be 249 gallons or 2.34 times the maximum daily rate of 175 gallons per capita as an average for the larger cities. For New England the average per capita daily consumption appeared to be but 68 gallons and for the maximum day 110 gallons per capita —(1.66 times the average). For the whole of the United States the hourly maximum consumption appeared to be 13.3 gallons per capita for the larger cities and 15.4 gallons for the smaller municipalities—(2.98 to 3.30 times the average hourly consumption). The average daily per capita consumption had varied between 68 gallons in New England to 309 gallons in the Rocky Mountain section. On the Pacific Coast the daily consumption had been 202 gallons per capita for the larger cities and 356 in the smaller towns. There the maximum hourly consumption reaches 49 gallons per capita during hours of garden and lawn sprinkling.

NOTE:—Lack of space necessitates completing this report in the next issue of WATER WORKS AND SEWERAGE in which topics on water quality and treatment will be dealt with.—*Editor.*

NOTES ON OPERATION OF THE DEARBORN SEWAGE TREATMENT PLANT

By MARK B. OWEN

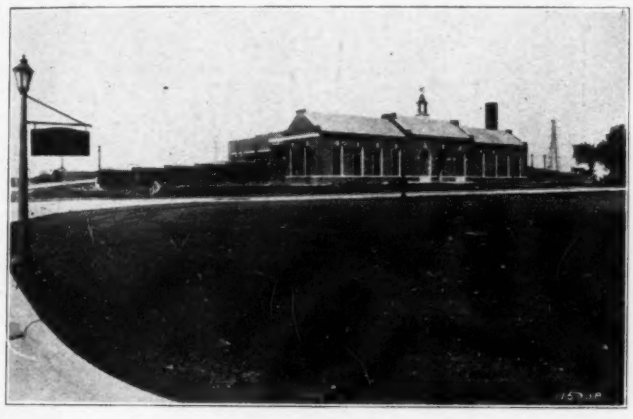
Superintendent Department of Public Works and Engineering, Dearborn, Mich.

ONE year ago, in the October issue of WATER WORKS AND SEWERAGE, appeared a complete description of the new Dearborn Sewage Treatment Plant. Now after about six months of operation something can be said concerning results from the mechanical-chemical process employed.

At Dearborn we have a treatment problem far more difficult than anticipated. For example, the sludge from the East Side sedimentation tanks (modified Imhoffs) arrives at the new plant in a very septic condition. Further, the West Side interceptor being completed less than a month ago was the result of our having an irregular flow of sewage from weak to strong.

Character of Sewage and Sludge

Up to the present time the sewage flow has averaged about 1 m.g.d. and the East Side sludge about 500,000 gals. per day. The character of both sewage and sludge during this period had a range as shown below.



Front View of Dearborn Sewage Treatment Plant, Before Landscaping.

Entrance Foyer Dearborn Sewage Treatment Plant. Laboratories on Right, Pump Room on Left, Treatment Plant to Rear.

	West Side Sewage		East Side Sludge	
	Max.	Min.	Max.	Min.
Settleable solids	20.0	0.0	700	2.3
Suspended solids.....	2,752	25	45,000	185
Total solids	3,268	305	46,000	883
B. O. D.	1,190	17	7,000	66

Screening

Two Laughlin travelling, self-cleaning screens of a new type are installed just ahead of the sewage pumps. The screens are constructed of Everdur bronze and stain-

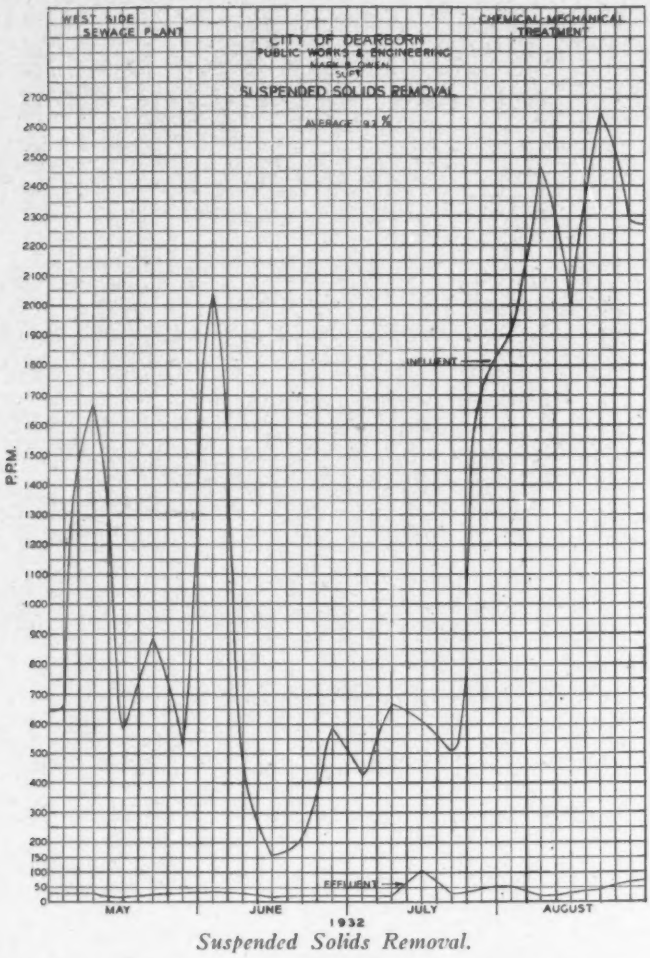
SIX MONTHS' OPERATING RESULTS AT THEDEARBORN CHEMICAL-MECHANICAL SEWAGE TREATMENT PLANT

WEST SIDE SEWAGE PLANT — CITY OF DEARBORN PUBLIC WORKS & ENGINEERING MARK B. OWEN, SUPT. 1932 — CHEMICAL-MECHANICAL TREATMENT

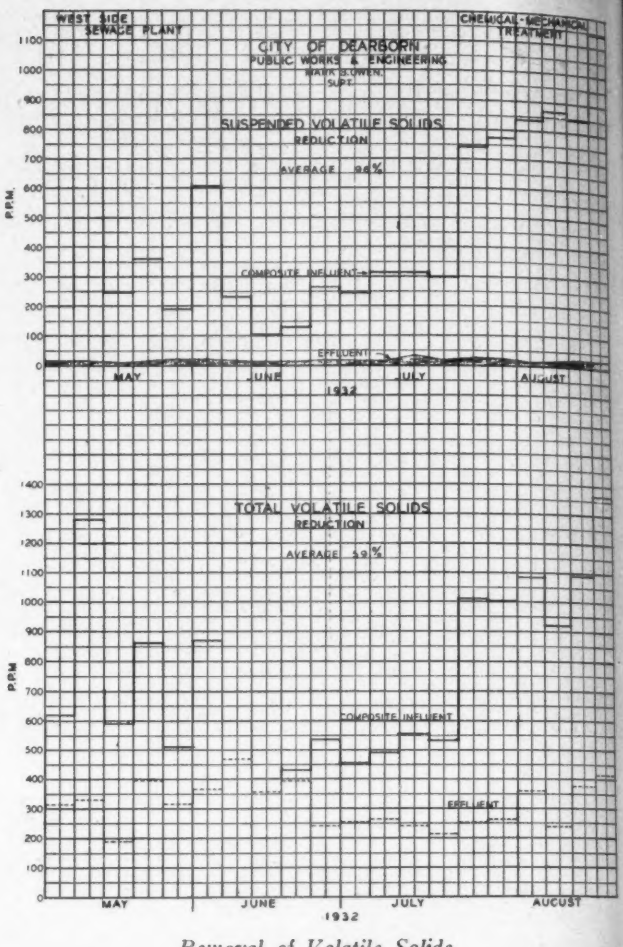
OPERATING RESULTS

	MAY					JUNE					JULY					AUGUST					PER CENT REDUCTIONS		
	SEWAGE INFLUENT	EAST SIDE SLUDGE	COMPOSITE	EFFLUENT	REDUCTION %	SEWAGE INFLUENT	EAST SIDE SLUDGE	COMPOSITE	EFFLUENT	REDUCTION %	SEWAGE INFLUENT	EAST SIDE SLUDGE	COMPOSITE	EFFLUENT	REDUCTION %	SEWAGE INFLUENT	EAST SIDE SLUDGE	COMPOSITE	EFFLUENT	REDUCTION %	MAXIMUM	MINIMUM	AVERAGE
VOLUME - M.G.	27.55	14.07	41.61			17.87	14.50	32.83			19.04 5.24	3.21	8.51			3.62	13.27	13.82					
SETTLEABLE SOLIDS	2.0	65.7	6.4	–	100	2.8	28.0	5.0	–		4.3	40.1	19.1	–		2.16	59.0	20.2	–				
SUSPENDED SOLIDS	202	3660	855	26	97	347	3748	696	24	96.6	494	4450	1670	*25 45	95 97	343	7160	2330	43	98	98	95	97
TOTAL SOLIDS	738	4750	1690	537	68	918	4460	1286	612	52	957	5160	2260	*248 517	59 77	822	7750	2800	645	77	77	59	70
VOLATILE SUSPENDED SOLIDS	95	1210	313	16	95	174	1011	266	16.5	94	284	1945	760	*19 26	93 97	139	2310	850	21	97	97	93	96
VOLATILE TOTAL SOLIDS	387	2650	777	312	60	482	1348	566	366	35	466	2340	1062	*233 279	50 74	375	2640	1050	333	68	74	50	61
OXYGEN CONSUMED	58	505	152	18	88	86	610	154	16	89.5	83	658	361	*16 29	81 94	100	1010	397	19	95	94	81	92
B.O.D. 5 DAY	81	905	243	37	85	154	800	223	37	83	267	1060	521	*43 76	82 85	132	1670	668	58	91	91	82	87
DISSOLVED OXYGEN				5.6					3.8					*3.0 5.0					4.0		5.6	3.0	4.3

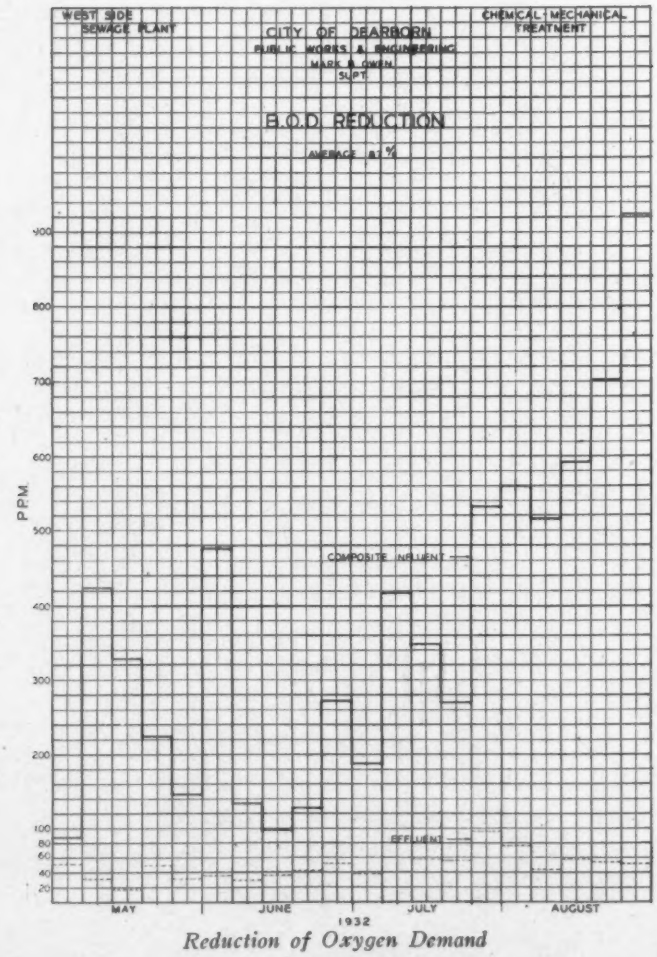
NOTE:
* First three weeks operation on sewage only. Last week sewage and East Side sludge.



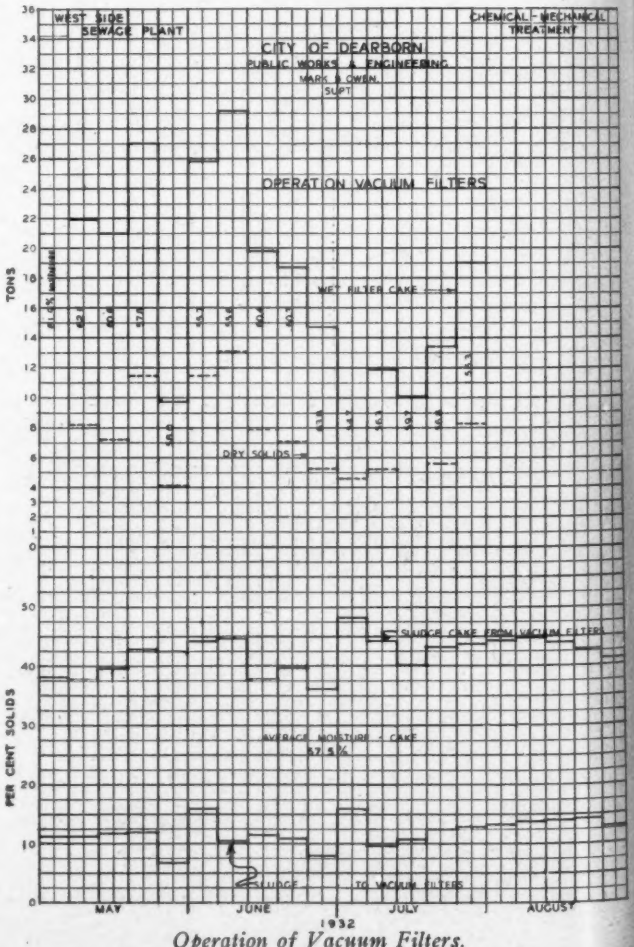
Suspended Solids Removal.



Removal of Volatile Solids.



Reduction of Oxygen Demand



Operation of Vacuum Filters.

less steel. So far their performance has been quite satisfactory.

Chemicals

Both quicklime and carbide sludge which contains lime have been used as coagulants. From a nearby Prestolite plant the spent carbide sludge is obtained and delivered at the plant for less than $2.00 per ton. This material contains on the average 32 per cent lime in terms of calcium oxide. The moisture content when received is approximately 50 per cent.

Ferris chloride is made at the plant from scrap iron, chlorine and water. Some difficulty has been experienced in operating the generator and at the present time one tower is being remodeled and will be ready for operation very soon. Ferric salts have been purchased in the interim.

Paper pulp is supplied as waste paper collected from schools and other public buildings. The supply is more than sufficient for the plant requirements.

Chemical Feed

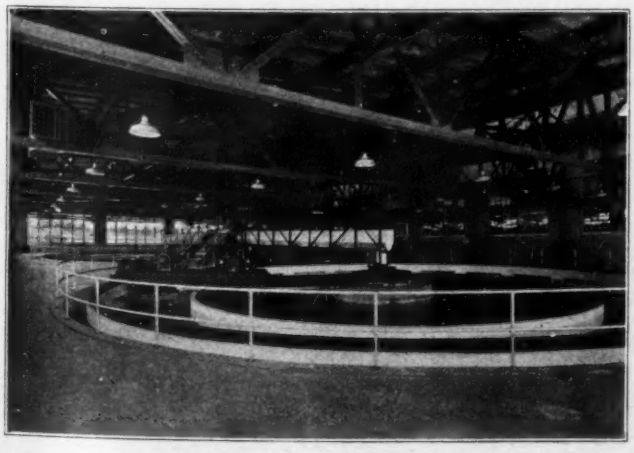
Prestolite lime and paper, diluted with clarified sewage, are fed to a pebble mill which produces a slurry. This is pumped to a baffled mixing chamber where it meets the mixture of incoming sewage and sludge. Just after this mixing ferric chloride is added and the treated sewage then enters two clarifiers. The dosage varies with the character of incoming sewage and sludge. Average feed in p.p.m. is as follows:

	Lime (CaO)	Ferric Chloride	Paper
May	123	36	52
June	54	31	38
July	73	37	29
August	294	45	48
Average	150	31	36

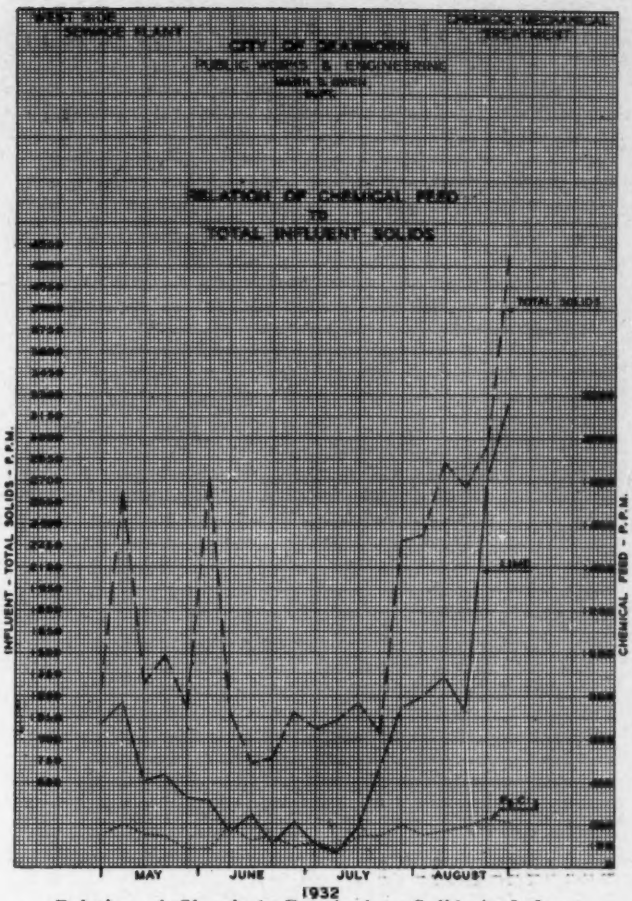
Laughlin Clarifiers

Two circular tanks 60 ft. in diameter, 9 to 11 ft. deep are in alternate use. These are equipped with Dorr sludge scrapers and the Laughlin magnetite filter. The travelling magnetic cleaner is attached to the Dorr mechanism as described in WATER WORKS AND SEWERAGE of October 1931. The results obtained with this apparatus have been very gratifying and far exceed the results expected and demanded. No trouble has arisen except that created by carelessness of operation. Tests made to determine what percentage of solids the magnetite bed was removing has shown the average to be 75 per cent.

Removal of suspended solids is maintained at a high level as can be seen on the graph—the average for four months being 97 per cent. It will be noted that during three weeks in July when sewage alone was treated an average of 25 p.p.m. suspended matter was carried by the effluent and that the overall removal was 95 per cent.



Sedimentation and Filter Tanks, 60 Ft. Diameter, at Dearborn Sewage Treatment Plant.



Relation of Chemicals Required to Solids in Influent.

The capacity of these clarifiers is based on the magnetite filter rate of 2 gallons per sq. ft. per minute sedimentation period at this rate being 2½ hours. Indications are that a much reduced period or retention would produce just as satisfactory results.

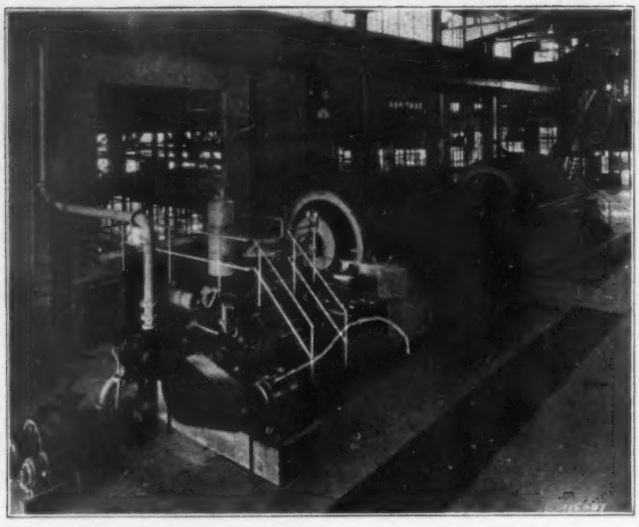
Sludge

Sludge is completely drawn from the tanks daily and dewatered on two 8x12 ft. Oliver vacuum filters. We have on many occasions obtained a filter cake more than ½-in. in thickness, containing less than 60 per cent moisture. Generally the filter cake is about one-quarter inch thick and averages under 60 per cent moisture. The filter cloths have given excellent service—one cloth lasting two months. The accompanying chart shows results obtained from the Oliver filters.

Sludge Disposal

Some experimentation has been under way looking to the ultimate plan of sludge cake disposal. About ten acres of land around the plant has been given a heavy application and then ploughed. The area for lawn in front of the building was given several applications before seeding. At the present time the ground appears to have a great tendency for holding water and a beautiful lawn is already in existence. A large compost pile has been built by our forester, using earth, garbage, and sludge. Another has only earth and sludge. It is too early to report on the success of the schemes.

Some work has been done using moulds. Although conditions were not the best for this work some very interesting results were obtained.



Oliver Vacuum Sludge Filters, Dearborn Sewage Treatment Plant. Clarifier Tanks Visible Through Windows.

Work has been done on incineration. It is hoped that in the very near future a furnace will be installed. The writer has always been in favor of this method and believes this to be the ultimate answer to the sludge problem in all plants.

Grit and Screenings

This plant employs no grit chamber. Grit is allowed to pass into the tanks and is disposed of with the sludge.

Grit from the East Side plant is put through the pebble mills and with extra pebbles acts as a grinding medium, being worn out by attrition and entering the clarifiers with the lime slurry.

Screenings also are disposed of in the same manner as grit.

Personnel

The plant is in charge of a chief engineer, E. C. Miller. in addition to two men in the laboratory he has a chief operator, three operators, two assistant operators, one janitor and two men with a truck to haul lime sludge, collect paper and perform other work.

Costs

The plant investment, including complete heating, ventilating, roads and lighting, laboratory equipment, railroad siding and crane, engineering and inspection, but not land is $501,702.

Operating costs are always important and especially has that been so in this plant. Every inquiry carries the question, "How much per million gallons"? Very early in the life of our plant we realized that treating only part of our normal sewage flow and a small volume of East Side sludge would make it impossible to arrive at a cost per million gallons that meant much to other cities. It can readily be seen from the graphs that our composite volume of 1½ m.g.d. carries a large volume of solids. Therefore the costs should really be based on solids and not on liquid volume. We know that our costs are below what we expected them to be, and that the cost per million gallons will probably fall between $7.50 and $12.50.

Until the entire connected load to our interceptor becomes available—which will be very soon—the writer does not wish to publish misleading costs. It is hoped that in the very near future this information can be determined accurately and so presented.

Conclusion

The process has more than exceeded our expectations and we expect that it will continue to do so; and to increase in efficiency as long as we continue to study it and profit from our studies. A great many minor changes in operation have been made and it is planned to make some minor changes and additions to equipment that will undoubtedly further improve the quality of effluent. The first six months of operation have to a considerable extent been experimental, but the next six months should produce reliable data of value.

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Rutgers University Announces Advanced Evening Courses in Water Supply and Sewage Treatment

The Extension Division of Rutgers University in cooperation with the College of Engineering announces an advanced evening course for engineers, chemists, and water and sewage plant operators, to be given at New Brunswick during the year 1932-33.

It is the purpose of this course to offer an opportunity to men with general engineering training to specialize in this branch of sanitary science, thereby attaining knowledge of treatment processes and methods of control and experience in plant design.

Although admission to the course will be limited largely to technical graduates, arrangements have been made to adjust the requirements in order to admit others who have taken basic courses in chemistry, calculus, strength of materials, plain and reinforced concrete, and elementary structures.

Classes will be held on Monday and Thursday evenings in New Brunswick for a period of twenty-four weeks. Three hours each evening will be allotted for instruction. Classes will start Monday evening, October 24, 7:15 o'clock.

DESCRIPTION OF COURSE

Public Water Supplies

12 weeks—October 24, 1932 to January 19, 1933.

Water Works Design

Water consumption; surface and underground waters; hydraulics; wells; pipe lines and distributing systems; reservoirs; pumps and pumping stations; treatment plants; design of a distributing system and treatment plants.

Professor H. N. Lendall.

Water Treatment

Chemical composition of waters; treatment of water for domestic and industrial use; chemistry of coagulation; filtration and disinfection; causes of scale formation, corrosion and methods of treatment; chemical, bacteriological and biological analyses for potability and industrial uses.

Dr. W. Rudolfs.

Sewerage and Sewage Treatment

12 weeks—January 19 to April 13, 1933.

Sewerage Design

Sewage flow; rain fall and run-off; hydraulics of sewers; design of storm and sanitary sewers; sewer appurtenances; characteristics of sewage; sewage treatment plants; sedimentation tanks; filters; sludge digestion; sludge beds; aeration tanks; design of a sewerage system and units of different types of plants.

Professor Lendall.

Sewage Treatment

Chemical, biological and physical factors affecting sedimentation, stabilization and oxidation of sewage; reduction and oxidation processes; disinfection; chemical and bacteriological tests for proper plant control.

Dr. Rudolfs.

"OPERATION AND CONTROL OF AN INDUSTRIAL WATER SUPPLY RESERVOIR"

By P. W. FRISK

Manager, Chemical Laboratories, American Enka Corp., Enka, N. C.

P. W. Frisk.

PROGRESSIVE, wide awake industries, which require good water at a low cost, will invariably possess a well trained water works engineer, and furthermore, will keep in constant touch with the progress and development of new equipment and methods of treatment for the reduction of cost per unit volume. It is not sufficient to have water clear and safe with little or no consideration of how it may be made to serve its industrial purpose more efficiently and at the same time eliminate a part of the operating costs.

Industries which are producing fine quality materials must give close attention to their water supply resources. The company producing the purest water will have eliminated at the start many problems whcih would otherwise enter into their production difficulties.

Pulp, rayon and textile plants all require water of exceedingly high purity. The pulp plant, if producing a sulphite pulp for rayon production or the finest of paper, must have a water low in mineral content, particularly iron and manganese. The rayon plant, likewise, must have a water free from organic material and low in iron, manganese and hardness. The textile mill that weaves and knits the yarn requires a water clean and free from mineral salts.

It is the aim of the industrial plant to prepare a water which will in all cases fulfill its requirements. The industrialist who draws water from a large reservoir must be on the constant lookout. He must first protect the water shed from becoming contaminated with impurities which will either be objectionable immediately or cause trouble later. These protective measures may be of various kinds. A fence surrounding the reservoir may keep out wandering animals and trespassers. A second measure is the inspection and control of the stream which feeds the reservoirs. Third, the eventual accumulation of impurities, due to precipitation of inorganic salts and re-dissolving during seasonal changes must be taken into account.

It is a common occurrence in reservoirs[1] during summer months for the turbidity of the upper strata to decrease with an increase of oxygen and, consequently, an increase of impurities at the bottom with an increase of carbon dioxide and a decrease of oxygen. With this phenomenon there exists a splendid condition for the action of organic matter, particularly small vegetable life, to grow and live, which in turn produces an action

[1]Manganese in Reservoirs, WATER WORKS AND SEWERAGE, January, 1932.

Air Plane View of the Reservoir of the American Enka Corp., Enka, N. C.

on the soil which dissolves many of the mineral constituents, and as subsequently during the fall a general mixing takes place, this raises the average mineral content of the water. One may expect considerable difficulty with an increase in the cost of water treatment during the period when these materials have become completely diffused throughout the body of water. In order to prevent and minimize such a condition, one may provide for a drain at the bottom of the reservoir, which can be opened at intervals during the gretest concentration at the bottom. Thus part of this accumulation may be eliminated. It has been the experience of the writer that this phenomenon of lake stratification takes place in almost every reservoir[2] and at the same time produces an unfavorable condition from the standpoint of water purification.

The evaporation of a lake or reservoir is always worth giving some attention to in the consideration of the concentration of impurities. Water which evaporates contains no mineral constituents, is the purest of all water and, consequently, leaves the impurities behind to build up concentration in the remaining water.

A plant designed and equipped to treat the water at the beginning may be obsolete in some respects[3], if the foregoing conditions were to be the case unavoidably. To be prepared for any new circumstances, the industrial water works engineer must be constantly making a study of the conditions and circumstances.

During a period of irregular plant production, consideration might well be given to increasing the efficiency and lowering the cost of water treatment. In a plant with a four unit gravity filter with an ultimate capacity of 5,185,000 gals. per day, the present operation is but 40 per cent. During this period, but cutting down the filter rate of each filter, the operation is more nearly uniform, producing better coagulation and precipitation with a decrease of chemical consumption and increase of filter runs.

One may also recondiiton the sand by raking and at the same time blowing air through the water, breaking up the hard spots and mud balls, which, otherwise, could not be done so readily. The cleaning of the filter sand must be considered an important item in the efficient operation of a filter plant. Many studies have revealed that the physical condition of the sand produces both longer filter runs and ultimately smaller consumption of chemicals.

The filter plant operator may save or waste chemicals, depending upon the thoroughness with which he is provided with proper testing equipment. It is usual at an industrial plant to have a laboratory where daily or hourly control by chemists may be exercised. In this case, the filter plant operator will only be required to make simple tests, such as the turbidity and temperature of the raw water and the specific gravity of his chemical solutions.

In one plant, tests are made on each shift to determine the pH of the water after mixing with the chemical, the turbidity of the raw water and the effluent, residual chlorine in the prechlorinated water and iron and manganese in both raw and filtered water. In this plant the water must be exceedingly pure but, due to the constancy of a reservoir supply, more frequent testing is not necessary. However, twice each month a complete analysis of both raw water and clear filter effluent is made.

Other plants, which depend upon a river as a source of supply, must make more frequent tests for turbidity, pH and dosage control. In either of the two, the operation and treatment of raw water is considered simple.

The fundamental testing equipment for a filter plant with auxiliary laboratory in the mill may be said to be apparatus for determining pH, a chlorometer, turbidimeter, a burette for titrating the alkalinity and necessary hydrometers and thermometers. With these instruments the filter plant operator may be able to control the water treatment within very narrow limits. The plant laboratory can then do the more complete analyses and make special tests for coagulation and sedimentation.

[2]Japanese Reservoirs, *Chemical Abstracts*, Vol. 26.
[3]Improved Mechar cal Treatment of Water for Filtration, WATER WORKS AND SEWERAGE, April, 1932.

Association Meetings Scheduled

Oct. 11-12—Wisconsin Section American Water Works Association. 11th Annual Convention, Hotel Northern, Appleton, Wis. Secretary, L. A. Smith, Superintendent Water Works, Madison, Wis.

Note: West Shore Water Producers Association will meet jointly with the Wisconsin Section. Geo. B. Prindle, Secretary.

Oct. 12-13—South Carolina Water Works Association. 6th Annual Convention, Hotel Aiken, S. S. P. G. Hasselel, Secretary, Columbia, S. C.

Oct. 13-14—Ohio Conference on Sewage Treatment. 6th Annual Meeting, Hotel Neil, Columbus, Ohio. Secretary, F. D. Stewart, State Department of Health, Columbus, Ohio.

Oct. 13-14—Missouri Water and Sewerage Conference. 8th Annual Meeting, Hotel Bothwell, Sedalia, Mo. Secretary-Treasurer, Herbert Bosch, State Board of Health, Jefferson Cty, Mo.

Oct. 14-15—New York State Sewage Works Assocaton. Fall Meetng, Hotel Saranac, Saranac Lake, New York. Secretary-Treasurer, A. S. Bedell, State Department of Health, Albany, New York.

Oct. 17—New England Sewage Works Association. Semiannual Meeting, Hotel Stratfield, Bridgeport, Conn. Secretary, F. W. Gilcreas, 14 Beacon St., Boston, Mass.

Oct. 19-21—Pennsylvania Water Works Association. 37th Annual Convention, Hadden Hall Hotel, Atlantic City, N. J. Secretary, F. S. Purviance, Telegraph Bldg., Harrisburg, Pa.

Oct. 22-24—Conference State Sanitary Engineers. Annual Meeting, Hotel Willard, Washington, D. C. Secretary-Treasurer, R. E. Tarbett, U. S. Public Health Service, Washington, D. C.

Oct. 24-27—American Public Health Association. 61st Annual Meeting, Williard Hotel, Washington, D. C. Executive-Secretary, Homer N. Calver, 370 Seventh Ave., New York City.

Oct. 24-26—International City Managers' Association. Hotel Gibson, Cincinnati, O. Executive Director, Clarence E. Ridley, 923 East 60th St., Chicago, Ill.

Oct. 25-27—Missouri Valley Section American Water Works Ass'n. 18th Annual Meeting, Sioux City, Iowa. Secretary, E. L. Waterman, Prof. of Sanitary Engineering, University of Iowa, Iowa City, Iowa.

Oct. 26-28—Rocky Mountain Section, American Water Works Association. 6th Annual Meeting, Denver, Colo. Secretary, Dana E. Kepner, Pacfic States Cast Iron Pipe Co., 226 Continental Oil Bldg., Denver, Colo.

Oct. 26-29—California Section, American Water Works Association. 13th Annual Convention, Coronado Beach, Cal. Secretary-Treasurer, R. F. Brown, 336 East Market St., Stockton, Cal.

Oct. 31-Nov.1-2—North Carolina Section, American Water Works Association. 12th Annual Meeting, Hotel Robert Lee, Winston-Salem, N. C. Secretary-Treasurer, H. G. Baity, Prof. Sanitary Engineering, Univ. of N. C., Chapel Hill, N. C.

Nov. 7-11—Tenth Short School Texas Public Health Association. Hotel Baker, Dallas, Texas. Laboratory Sessions to be held at Baylor University. C. F. Browning, 1836 Fairview Ave., Houston, Texas, Secretary. Dr. J. W. Bass, City Health Officer, Dallas, is Director of the 1932 School.

Nov. 14-15—Virginia Water and Sewage Works Association. 4th Annual Meeting, Stonewall Jackson Hotel, Staunton, Virginia. Secretary, H. W. Snidow, 601 State Office Building, Richmond, Va.

Jan. 16-18—American Society Municipal Engineers. Annual Convention, Detroit, Mich.* Executive Director, C. W. S. Sammelman, 4359 Lindell Blvd., St. Louis, Mo.

*Originally scheduled for New Orleans, Nov. 14.18.

SEWAGE DISPOSAL WORKS

A Section Dealing with Sewerage and Sewage Disposal Research, Operation, Design and Construction.

Conducted by S. I. ZACK, Associate Editor
Sanitary Engineer, Chicago, Ill.

TAKING STOCK OF SEWAGE DISPOSAL

IN the early days of American growth, even up to less than a decade ago, it was possible for a community to discharge its sewage into a stream and rely upon the elements of purification by dilution to take their natural course. With the growth of centers of population and industries, many of the bodies of water have become inadequate to fulfil the two-fold purpose of supplying a safe water for domestic use and at the same time serve as a means of sewage disposal.

Communities have therefore been faced with either or both problems of water supply or sewage disposal based on their own needs or the requirements of State Departments of Health to protect the rights of other municipalities on the same watershed. These problems have been dealt with chiefly from the standpoint of sanitation and economics, only as urgent requirements necessitated, without regard for the esthetic features involved.

The more recent awakening of the average citizen to the value of the outdoors for recreation and health is creating agitation to preserve and bring back the watercourses to their natural state, taking into consideration the conservation of fish life in addition to the protection of water supply. Such movements are being sponsored by the Izaak Walton League, thus creating needs for artificial sewage treatment in a larger number of localities. However, owing to a reluctancy on the part of the average citizen to pay for something which is thrown away, the installation of sewage works is generally postponed as long as possible and progress in this field has been retarded.

Because of its organic composition, the matter of conversion to stable compounds is of complicated nature. The pioneer research work and developments have been shouldered by those few localities who have had immediate and acute problems to deal with. These in the process of solving their own problems have contributed considerably to the advancement of the art. The field of sewage disposal with the possibility of lucrative returns has attracted the interest of manufacturers and enterprisers in the development of equipment and processes for sewage purification. Much has already been accomplished by these interests and a great deal is in the process of development at the present time.

Sewage treatment basically consists of (1) the removal of suspended solids; (2) the removal by oxidation or precipitation of dissolved, colloidal and putrescible matter rendering an effluent sufficiently stable for discharge; (3) handling and disposal of sludge.

Screening and plain sedimentation are effective in removing a relatively large proportion of the suspended solids. The chief processes employed for the more complete treatment are activated sludge, trickling or sand filters, depending on local requirements and conditions. The use of chemicals for precipitation and disinfection, recently brought to the foreground, has indications of providing a degree of treatment where plain sedimentation is insufficient and activated sludge or filters provide an effluent better than local stream conditions actually require.

The matter of sludge handling and disposal is at present in a rapid stage of development. The production of fertilizer from activated sludge although affording a very satisfactory means of sludge disposal from the scientific standpoint is limited by the economic aspects, particularly market and price. Unfortunately the production of a high grade fertilizer is dependent on the degree of treatment and necessitates nitrification to a greater extent than is necessary for most stream conditions. Digestion of sludge whether in Imhoff, heated or unheated separate digestion tanks, involves the drying on covered or open beds and final disposal on dumps. For the larger thickly populated centers, this may at best be considered only as a temporary means pending the development of more desirous methods. Dewatering, followed by sludge cake incineration and final disposal of the ash appears to be the most practical solution for these communities even if at slightly greater costs. The results of large scale investigations recently put under way must be awaited before the workability and economics of this method are known. Present indications are that operation costs of dewatering and incineration may stand in the way of its adoption for smaller installations. However, it may prove feasible to combine the incineration of garbage with sludge to reduce unit costs.

The trend has been in the adaptation of mechanical equipment in the treatment of sewage, consisting of mechanical detritors, sludge thickeners and conveying apparatus, surface skimmers, aerators, air diffusers traveling distributors for filters, magnetically cleaned filters in combination with chemical precipitation tanks, apparatus in separate digestion tanks, sludge bed cleaners, dewatering equipment, sludge dryers and incinerator, meters and recorders, and apparatus for dosing of chlorine and other chemicals. Manufacturers have been alert to the needs of mechanical devices in sewage treatment and have developed new mechanisms or modified equipment designed for other uses for these purposes. Municipalities alone or upon advice by consultants have readily adopted such new equipment as soon as sufficiently proven. Competing mechanisms of equal merit are now available on the market for definite functions in the plant, and aside from designing tanks to conform to the specific equipment, purchases from reliable producers can be safely made on basis of price.

Although new developments in the art of sewage treatment are still proceeding and will continue to proceed, the already proven methods may be considered as being at the end of the experimental era, and passing into the early stages of standardization. It should be

borne in mind, however, that a treatment plant will only accomplish the work for which it was intended.

A survey of treatment plants constructed in recent years will indicate that difficulties encountered are due chiefly to faulty design or faulty operation rather than to a defective process. A city must not alone be extremely careful in the choice of a competent engineer to design treatment work but also must provide adequate funds for proper operations and control.

Too little attention is given to treatment plant loadings on the basis of chemical constituents of the sewage which must be handled as it actually comes to the plant. A reasonable amount of time and effort spent in an analysis of the material to be treated would be well invested and avoid considerable difficulty later. State Department of Health requirements are partially at fault in the standards set up. These, on a per capita basis, are often found inadequate when the solids or biological oxygen demand in pounds per capita are greater than normal as the result of the presence of an industrial waste load. A proper balance in all cases between the stream or watershed conditions and the effluents discharged are desirable as the governing factor in the degree of treatment to be provided rather than some of the national specifications now set up.

In the past, except for the integrity of its consultant and guarantees of the mechanical operating features, a community was at the mercy of the heavenly elements and had no practical assurance that its plant would serve its needs. It is also because of the projects that became failures through incompetent design or through obsolescence that the taxpayer, except in the case of dire necessity, has been reluctant in authorizing large sums of money for sewage disposal. At present the art is sufficiently advanced to assure the successful operation of a project, and with later stages of standardization will come more definite guarantees, either by consultants or promoters of processes and equipment.

The burden of sewage treatment is very often magnified by the presence of industrial wastes. The location or expansion of an industry frequently overloads the capacity of the bordering body of water or of an existing treatment plant, hastening the need for new construction or extension of existing facilities for sewage disposal. As to whether this waste shall be treated in a separate plant or combined with the domestic flow is a matter for the engineer and chemist to decide, being considered technical phases and costs. The matter of policies as to cost distribution rests on the taxpayer or councilman. Many municipalities exist because of their industries, who through their real estate and property holdings contribute the greatest portion of the tax funds for civic use. In this depression period most industries are confronted with keen competition and a struggling effort to show profits. In many instances, especially where revenue for sewage disposal is derived from general taxation it may be the more practical policy for the merchants and citizens of the town or city to assume some of the increased cost of sewage treatment due to industrial wastes rather than unduly burden or harass the industrial establishment. Where the industrial load is manyfold greater than the domestic population, much can be accomplished through cooperation between the industrial and domestic interests. Revenue derived from a service charge which takes into consideration the flow or sewage loads appears to be a fairer method of distributing costs of sewage treatment than that based upon general taxation. Especially is this true where industrial wastes are involved.

In general the construction of sewers and sewage treatment work has not kept pace with the actual modern needs of population. At present sewage treatment developments are practically at a standstill, due to limited tax funds and the very dull market for municipal bonds. Nearly half a billion dollars worth of work on which bond issues have been approved is awaiting improvement in the bond market.

There is a general agreement that the construction of needed public works is one of the most feasible plans to consume materials and furnish labor without adding to the surplus marketable goods. Municipalities may borrow funds from the Reconstruction Finance Corporation for the construction of income-producing self liquidating projects. Loans may therefore be secured for sewerage and sewage disposal where service charges or rental charges are in effect. A recent survey of local governments sewerage and sewage disposal needs, according to their own opinions, indicates an estimated cost of needed projects of about 2.2 billion dollars of which 60 per cent is in states that permit municipalities, under authority given in the general code or by enabling acts, to levy a service or sewer rental charge.

In view of the present status of the art of sewage treatment and the agitation for clean streams, there is no need for further postponement, and any municipality faced with an unemployment problem can find no better solution than is offered by the construction of sewerage and sewage disposal facilities. No other type of public works offers a wider distribution of labor and money than does the construction of sanitary improvements.

Service or rental charges not only present itself as a fair and competent way of distributing the cost for sewerage and sewage disposal on the individual as well as the industry, but it affords a direct means of revenue, on the basis of which financing can be accomplished by the municipality through loans from either the Reconstruction Finance Corporation or private agencies.

General adoption of rentals or service charges will lead to more rapid completion of and adequate facilities for sewage disposal from the standpoint of design, construction and operation. It will also create a new field for and attract private enterprise looking toward the development and management of sewage disposal projects.

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Quality of the Colorado River Water

Passing through the Grand Canyon in Arizona the 5-year average load of dissolved solids carried in the waters of the Colorado River amounts to 33,100 tons daily. The average load of suspended matter carried down to the sea amounts to between 172,000,000 and 396,000,000 tons annually.

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Letter to Editor

To the Editor:

"On page 245 of the July issue of WATER WORKS AND SEWERAGE, a half-tone is shown of a small Oliver filter-unit dewatering sewage sludge.

This half-tone was made from a photograph taken at the Griffith Park sewage plant in Los Angeles, which is under the supervision of R. F. Goudey.

This particular photograph was used to illustrate the type of cake obtained because a photograph of the Columbus filter-unit, that would be suitable for half-tone reproduction, could not be gotten.

D. F. Irvin,
Oliver-United Filters, Inc., New York, N. Y.

WHERE DRY HYPOCHLORITES PAY IN WATER WORKS PRACTICE

By J. A. KIENLE
Vice President-Director of Sales
The Mathieson Alkali Works (Inc.)
New York, N. Y.

John A. Kienle.

SINCE the introduction, a few years ago, of a stable calcium hypochlorite product with twice the available chlorine concentration of ordinary chlorinated lime, the feeling then prevalent that dry chlorine-carriers were reaching the end of their usefulness in waterworks practice has been gradually reversed. Chlorinated lime had fundamental shortcomings from the standpoint of stability and solubility that limited its use and made results haphazard at best. For many special and emergency purposes, however, some ally of liquid chlorine which could be applied without elaborate dispensing equipment was recognized as desirable. Now, there is considerable interest in the question: To what extent is the use of a non-hygroscopic, stable, and easily soluble dry source of available chlorine economically justified in comparison with liquid chlorine?

As soon as there became available a solid source of chlorine packed to yield a *definite concentration*, so that application in accurate dosage was possible, the choice between it and liquid chlorine became primarily one of the economics of transportation and application. The extent to which these economic factors control the choice of a source of chlorine solutions varies so widely with individual conditions that few hard and fast recommendations can be laid down. As the maker of both H T H, the product which brought this question to the fore, and liquid chlorine, the Mathieson Alkali Works realized that present users of liquid chlorine would be interested only in an absolutely unprejudiced view of the relative fields of use for these two products. And since many are also users of Mathieson liquid chlorine, such an attitude was mutually desirable. Because the economic questions involved are those of actual practice, users of the products themselves were regarded as the only possible source of the needed information.

To a representative list of those engaged in water supply and municipal sanitation work, a questionnaire was sent listing those uses for dry hypochlorites which have been regarded as economically justified under normal conditions, as well as uses which special conditions make desirable. Space was provided for reporting on uses developed by those replying and ways in which it was *actually being used.*

The fifty replies received to the section of the questionnaire dealing specifically with waterworks problems cover the entire range of water supply work from the standpoint of capacity of plants, methods of treatment, as well as location and accessibility. As a result, the divergence in the fields of use shown in the replies is very great. Obviously, it was not expected that large plants equipped with batteries of automatic feeding units for liquid chlorine would find a hypochlorite product valuable for the same purposes as it would be in connection with an isolated summer resort well-water supply, or a small municipal supply.

The most widely accepted use of this dry source of available chlorine, as revealed by the questionnaire, has been for the chlorination of pipe lines following construction and repair. More than 50 per cent of those replying use it for this purpose. The most common method has been to distribute the powder in the pipe sections as they are laid, and then, while the line is still cut off from the rest of the system, it is slowly filled with water. After standing for an hour or more, the water is flushed off through a hydrant at the further end of the new line.

Some of those using this method have evolved an accurate schedule of dosage for various sizes of pipe.* Others simply use "a little in each pipe length." One reply suggests, "One handful for every two pipes under 12 ins.; over 12 ins., one handful to a pipe." The water department of a large Eastern city reports highly satisfactory results with about ½ lb. of the powder at the beginning of each 100-ft. section.

Several of the replies favor the use of hypochlorite in solution form for treating new pipe lines. The method is described in detail by H. J. Schneider of the Oshkosh, Wis., water department. "The solution has about 150 to 200 p.p.m. chlorine," he writes. "We use a street flusher to pump the chlorine solution into the new pipe line. We isolate the new line from distribution by closing down line valves, and then pump the solution into the new line through a hydrant at one end and allow it to flow through the new pipe and discharge from a hydrant at the other. This is done until tests show a strong

*See WATER WORKS AND SEWERAGE, October, 1931, pp. 299-300. *Water Works Engineering*, April 6, 1932, pp. 372-373. WATER WORKS AND SEWERAGE, May, 1932, pp. 164-165. *Water Works Engineering*, August, 1932, pp. 1014-1015.

Water in the 35,000,000-gal. reservoir at Wilmington, Del., is chlorinated periodically by scattering HTH over the surface from a row boat

amount of chlorine being discharged. The solution is then allowed to remain 48 hours in the line. The pipe is then thoroughly flushed and tested bacteriologically before being tied in with the distribution system."

If one can judge by the results of this survey almost half of those who use H T H in waterworks practice keep a supply on hand for emergency or stand-by chlorination. For such stand-by use, several report having tanks or barrels on hand so elevated that the rate of flow of hypochlorite solution will maintain the required dosage should regular chlorination with liquid chlorine be interrupted. These tanks are kept filled with water, and the cans of hypochlorite powder near by. For this use, the advantages of the true calcium hypochlorite over chlorinated lime in respect to stability are particularly important. Many report, of course, that no emergency has yet developed, and meanwhile an unstable product would have become worthless. "We have used it but once, but it did the work," one answer reads. One Florida waterworks superintendent includes "sterilization of water in case of disasters such as hurricanes when the regular water supply may be interrupted" as a reason for maintaining such a stand-by supply.

When emergency sources of water supply such as streams or wells are called into service during periods of drought, several cite use of hypochlorite to disinfect such sources before they are combined with the regular water supply. As the point of application in such cases is usually more or less inaccessible there are marked advantages in transportation of a dry product in small non-returnable containers.

Several small municipalities, having a source of water supply for which they do not consider regular chlorination necessary, also keep an emergency supply on hand in case signs of pollution develop suddenly. In one rural community the waterworks department secures 4-lb. cans of the concentrated hypochlorite for users of water from privately owned wells that occasionally show signs of pollution.

Financial as well as operating emergencies play a part in determining fields of usefulness for the product, one reply indicates. A municipality which is financially unable to make any capital investment at this time is still assuring its citizens a safe water supply by use of hypochlorite powder at an operating expense within the necessary limits.

Among prominent water-supply contractors, the Layne-Texas Co. has made the product a standard specification for chlorination of water-wells during and subsequent to their construction. Instruction given to drillers call for its use for treatment of casing, pipe and screen; sterilization of slush pit fluid and drilling water, and chlorination of completed wells. Their specifications call for sufficient hypochlorite to give the static water in the well 5 p.p.m. of available chlorine.

Sterilization and Cleansing of Filter Sand

About one-third of those replying to the questionnaire tell of finding a concentrated hyopchlorite product valuable for sterilization and cleansing of rapid sand filters, elimination of algae growths and oxidation of inert organic matter when present in quantities sufficient to lower filter efficiency. The practice generally is to leave about 12 ins. of water above the sand level when it is cut out of service, and then to distribute the hypochlorite powder over the surface with an average dosage of one 4-lb. can per 100 sq. ft. After a 30-minute interval, the water is lowered to about 1 in. above the sand level and allowed to remain from 12 to 24 hours before backwashing.

At Fort Pierce, Fla., the dry powder is sprinkled over the surface of the filter bed after the water has been drained off, and then washed into the sand with a hose until the bed has 1 in. of water above the sand surface. Three of those with small filters who replied prefer to put the hypochlorite into solution in pails and then pour the solution into the filter. In one instance, 5 lbs. of H T H is mixed in a bucket with 2 gals. of water, stirred to an even consistency, and this slurry spread out evenly over the filter in which the water level has been drawn down 2 ins. above the sand surface. After being allowed to stand for several hours, the rewash valve is cracked, and the solution drains off through the sand during a period of an hour or more. The filter is then washed and put back into service.

Following rebuilding of filters at Warren, Ohio, a hypochlorite solution was added as uniformly as possible over the entire sand area. The rewash valve was then partly opened, filtering the water to the sewer until it showed residual chlorine. The valve was then closed, and the filter allowed to stand until morning before being washed again and put into service.

Algae and Bacterial Aftergrowths

Another popular use for a readily soluble dry chlorine-carrier has been for the control of algae and bacterial aftergrowths in storage reservoirs for treated water, as well as in standpipes and aqueducts. About 25 per cent of the replies mentioned its value in this field. The methods and dosages used vary widely with the individual situations to be met, but in general they involve a rather high periodic or intermittent dosage, during the summer season particularly. Several procedures have been patterned after that used by the Metropolitan District Commission of Boston to keep a mile-long aqueduct free from algae growths. Here monthly dosages of from 3 to 5 p.p.m. are applied for 24-hour periods. At Wilmington, Del., concentrated hypochlorite is directly applied during the summer months to a 35 million gallon open filtered-water reservoir to reduce occasional high counts and gas formers. For seasonal and periodic application, a stable chlorine-carrier that can be brought into service with nothing more complicated than a barrel or tank of the proper size has a flexibility that is highly advantageous.

At Bloomington, Ill., H T H was called into service to sterilize a new 1,500,000-gal. reservoir for treated water. Forty pounds were scattered over the bottom and inside walls, and the reservoir was then filled and allowed to stand for 36 hours. This water was then drained out through two miles of 20 and 18-in mains, sterilizing the mains as well as the reservoir. Subsequently, the reservoir was washed out with filtered water before being put into service. Tests of the water in reservoir and pipe lines showed a satisfactory bacteriological condition from the start.

Continuous or Intermittent Use

Obviously, use of concentrated hypochlorite for regular or continuous chlorination is limited to smaller plants for whom the facilities for the application of liquid chlorine do not, for one reason or another, justify the initial cost of chlorinating equipment. This was reflected in the replies to the questionnaire, which showed about 10 per cent using it for this purpose. At a summer resort where the population for a brief period is more than ten tmies the year-round figure, those in charge feel that the annual interest charges on chlorinating equipment necessary for the brief maximum demand would make that method more expensive than the use

of hypochlorite. They have found concentrated hypochlorite a satisfactory source of available chlorine.

At Villisca, Iowa, an automatic dispensing device known as the "Mixitt" is being successfully used for continuous application of hypochlorite solution without the usual difficulties for controlling the rate of flow. A solution is prepared from the dry concentrated hypochlorite in a reagent tank holding a week's supply.

Marked economies during a five-year period of successful operation have been secured by the use of this type of chlorine-carrier for the prechlorination of raw water at Steubenville, Ohio. From 15 to 30 lbs. of the dry, concentrated hypochlorite is dissolved, along with 1,200 lbs. of lime, in a tank holding 9,050 gals. of water. The proportions of each used are determined by the requirements of the raw water and the rate at which lime is being applied, being so adjusted that from 1.0 to 1.5 p.p.m. of free chlorine will be delivered into the mixing chamber. Economies have resulted from the "decreased burden on the other purification processes and consequent saving in more expensive chemicals," according to J. Sheldon Scott, chemist in charge. Other replies to the questionnaire cite the use of concentrated hypochlorite for prechlorination at seasonal periods.

Taken as a whole, the results of the survey indicate a recognition that a dry hypochlorite product, free from the limitations and objectionable features of chlorinated lime, is becoming increasingly useful throughout the field of waterworks practice. It has not proved a competitor of liquid chlorine, but rather a companion product desirable for the particular uses in which it proves to be the cheapest or most convenient source of available chlorine.

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Virginia Water and Sewage Works Association to Meet at Staunton, Va.

The fourth annual meeting of the Virginia Water and Sewage Works Association will be held in Staunton, Va., on November 14th and 15th, at the Stonewall Jackson Hotel.

H. W. Snidow, Secretary of the Association, and Assistant Engineer of the Virginia State Department of Health at Richmond, Va., writes that the scenic and historic location of Staunton at the head of the famous Shenandoah Valley and the new highway constructed by "Uncle Sam" along the very crest of the Blue Ridge Mountains in the Shenandoah National Park, should serve as a lure to out of state guests. Historic Lexington and the famous Natural Bridge of Virginia are a matter of about two hours' drive from Staunton over splendid new highways. Mr. Snidow suggests that this is a wonderful opportunity for mixing business and pleasure during that vacation planned but not yet taken.

The program follows:

MONDAY FORENOON

8:30 Registration.

9:15 Staunton's Water Supply—*Richard H. Catlett,* Chemical Engr., Staunton, Va.

10:00 Pumping Equipment and Use of Automatic Stokers. *E. H. Herbert,* Supt. of Pumping, Norfolk, Va.

10:45 Location of Service Reservoirs and Design of Pipe Systems for Best Distribution. *B. S. Parrish,* Supt. Public Works, Martinsville, Va.

Discussion led by *I. G. Vass,* Town Mgr., Waynesboro, Va., *L. Z. Johnston,* City Engr., Buena Vista, Va., *R. W. Catlin,* Town Mgr., Farmville, Va.

Announcements and Appointment of Committees.

MONDAY AFTERNOON

2:15 Ammonia-Chlorine Treatment at Richmond. *M. C. Smith,* Engr. Water and Electricity, Richmond, Va.

Discussion led by *L. H. Enslow,* Editor, WATER WORKS AND SEWERAGE, New York City, and *R. F. Wagner* Dir. Public Safety and Water, Lynchburg, Va

3:30 Maintenance of Water Meters. *Chas. W. Davis, Jr.,* Supt. Water Works, Petersburg, Va.

Discussion led by *L. J. Houston, Jr.,* City Mgr., Fredericksburg, Va.; J. F. Noll, Dir. Public Works, Harrisonburg, Va., and *R. F. Whitaker,* Supt. Water Works, Emporia, Va.

4:30 Question Box Discussion.

MONDAY EVENING

6:30 Convention Dinner.

Toastmaster: C. K. Brown, City Councilman.

Address of Welcome—Honorable Geo. A. Cottrell, Mayor.

Response—Willard F. Day, President, Virginia Water and Sewage Works Association.

Address—Dr. Warren F. Draper, State Health Commissioner.

A program of entertainment.

TUESDAY FORENOON

9:00 New Sewerage System and Disposal Plant at Orange, Va. *W. G. Ancell,* Town Mgr., Orange, Va.

9:20 Sewage Treatment Plant at Winchester. *P. P. Pilcher,* City Mgr., Winchester, Va.

Discussion of above two papers led by *Prof. F. J. Sette,* Assoc. Prof. of Sanitary Engineering, V. P. I., Blacksburg, Va.; *Stirling Williamson,* City Engr. Charlottesville, Va.; *L. B. Dutrow,* Town Mgr., Front Royal, Va.; *W. C. Swain,* Supt. Water Works, Victoria, Va.

10:30 Construction of Drilled Wells for Municipal Supplies. *Chas. F. Cole,* President, Va. Machinery & Well Co., Richmond, Va.

11:00 Success in Obtaining Water from Drilled Wells in Virginia. *Garland Sydnor,* Sydnor Pump & Well Co., Richmond, Va.

Discussion of both papers led by *W. F. Cocke,* Town Mgr., Manassas, Va.; *A. L. Meisel,* City Engr., Williamsburg, Va.; *C. H. Hardy,* Town Mgr., Blackstone, Va.

TUESDAY AFTERNOON

2:00 Chemical Analyses of Municipal Water Supplies in Virginia. *Prof. F. H. Fish,* Dept. of Chemistry, V. P. I., Blacksburg, Va.

2:30 Industrial Utility of the Surface Waters of Virginia. *W. D. Collins,* Chemist in Charge, Quality of Water Division, U. S. Geological Survey, Washington.

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A Thrill Experienced by Even the Blase New Yorker

Traffic on Broadway in the heart of the Times Square district was halted on the night of Oct. 10 when New York's thoroughfare of bright lights was blocked by the bursting of a 48 in. water main. Both subway and surface traffic was paralyzed in a 4-block area which was flooded knee-deep. Five gates had to be closed to stop the water. The Metropolitan Opera House, the building on the left in the picture, was flooded, resulting in considerable damage to costumes stored in the building.

"Water, Water Everywhere and Not a Drop to Drink." Times Square on the night of Oct. 10

PUMPING PLANT ECONOMIES

By L. A. JACKSON

Assistant Superintendent of Arkansas Water Company, Little Rock, Ark.

SOME one has said "Economy is great revenue." Emphasis on this axiom and the full utilization of every improved process in water works practice will effect some astonishing results.

The cost of fuel in the generation of steam for the average plant represents about ten per cent of operating expenses. If the cost of operating the boiler plant and the engine room is added to the fuel bill, the two combined represent the largest single operating expense item.

When it is further considered that the overall thermal efficiency of the average small steam pumping plant is less than 5 per cent and many of them unfortunately show efficiencies of even less than one per cent, a splendid opportunity presents itself to increase revenue through the prevention of power plant losses and elimination of waste.

The scope of this paper includes those losses that occur in the generation of the steam and the application of the power. The writer will attempt to trace each operation, name some of the more important losses and suggest corrective measures.

Fuel.—The coal should be carefully selected by analysis or from mines known to produce the grade best suited to your conditions. Variable quality of coal disturbs regular boiler room operation. Cars should be carefully checked to detect losses in transit and promptly unloaded to prevent demurrage charges. Sometimes it is economy to store a large supply. If storage is necessary care should be taken to prevent spontaneous combustion. Temperature readings of the pile should be frequently taken and if these give evidence of combustion the coal should be moved.

The average B.T.U. content of the coal should be known and if this figure is furnished by the mines it should be checked periodically by analysis. A complete boiler test is sometimes necessary to determine the merits of a coal and the proper method of firing. When you purchase coal it is well to remember that you are buying heat units and the cheapest coal is not always the best. When market conditions allow, coal should be moved continuously at the rate of consumption, with small storage, in order to keep inventory losses at a minimum. A record of weights of coal, received, and burned should be accurately kept and the monthly inventory shortage should be charged as fired and included in any efficiency and duty records that are kept.

Boiler Plant.—Generation of Steam: The boiler represents the element of the plant wherein the energy in the coal is changed to heat and the heat transmitted to the water to generate steam. Such conversion of energy invariably is accompanied by a loss.

Boiler efficiencies rarely exceed 75 per cent in the small hand fired coal burning plants. With so great a loss under perfect conditions it is important that frequent and accurate determinations of these efficiencies be made. To do this it is necessary to know the ratio of the energy absorbed by the boiler to that of the coal put into the furnace.

To calculate boiler efficiencies you must know—

		Example
1.	Weight of fuel (from weighing scales)	284,000
2.	B.T.U. content of fuel (average from analysis)	12,000
3.	Mil. B.T.U. input (Item 1 x Item 2)	3,410
4.	Pounds of feed water evaporated (from meter)	2,280,000
5.	Average steam pressure (pounds gauge)	125
6.	B.T.U. per pound of steam (from steam tables)	1,192.5
7.	Boiler feed temperature deg. Fahr. (from gauge), degrees	208
8.	B.T.U. per pound of boiler feed (Item 7-32) deg.	176
9.	B.T.U. per pound of steam from boiler (Item 6-Item 8)	1,016.5
10.	Mil. B. T. U. absorbed by the boiler (Item 4 x Item 9)	2,320
11.	Boiler efficiency in per cent (Item 10 divided by Item 3) x 100, per cent	70.5

Some plants make it a practice to calculate the performance of the boiler during each shift period. In this way each fireman's work may be gauged if the load is constant. Due to variable load the general practice is to make a daily calculation.

The process of generating steam in a boiler is perhaps the most prolific source of waste in the scope of water works practice. These losses may be classified as "Fuel Losses" and "Heat Losses." Unburned or partially burned fuel and unconsumed carbon gases represent the former and all heat units going up the chimney and lost by radiation represent the latter. They are found in the most carefully operated plants and to reduce them to a minimum requires continuous attention and a knowledge of the primary principles of combustion.

The following general rules, if observed, will tend to control or diminish these losses.

The fuel should be fed frequently and in small quantities, and evenly spread over the entire surface of a thin fuel bed. To prevent the admission of excess air firing doors should fit tight, be kept closed and air holes in the bed promptly covered. If carbon dioxide (CO_2) determinations are made on the stack gas the percentage present should be kept at the point where experience has shown to give the best results.

Stack losses represent 80 per cent of the total, therefore it is essential to regulate the damper, keeping it as nearly closed as possible, allowing only enough draught to efficiently burn the fuel and handle the load. A draft regulator appliance that automatically controls the damper from the steam pressure is very popular. Some firemen have even arranged a bell or light signal to tell them when the damper opens. If used intelligently these are efficient but too often the fireman develops lazy habits, firing large quantities of coal at a time, then sits and waits for the signal to fire again.

The boiler itself should receive careful attention. The setting should be tight and infiltration of air kept at a minimum by covering the exterior surface of the brickwork with one of the air tight compounds on the market. The entire exterior surface should be candled frequently to detect leaks, hollow stay bolt holes should be plugged and plastic asbestos mortar should be applied to insulate the water legs and exposed ends of the boiler drum.

The boiler should be kept clean, especially the heat transmitting surfaces. It is estimated that a 12 per cent

loss results from a 1/16-in. scale thickness. To reduce this scale formation the feed water should include as large a per cent of condensate in the "make up" water as is possible with your equipment. All other "make up" water, when containing encrusting solids, should be treated regularly and continuously with softening compounds. Even with perfect treatment the scale formation should be removed from the boiler tubes, etc., on each cleaning. Excessive scales if neglected will cause over-heating of the metal and burning out of the tubes.

Soot collects on one side of the tubes. This is almost as poor a heat conductor as scale and since it forms more rapidly it is important that it be removed at shorter intervals. The influence of this deposit on the heat absorption is evidenced by the drop in flue gas temperatures immediately after the tubes are "blown." To blow them each shift is good practice.

Each time the boiler is taken out of service the combustion chamber should be cleaned, the breeching and stack inspected at regular intervals and any accumulated deposit which interferes with the draught be removed. Baffle plates should be inspected with particular attention to openings which allow the short circuiting of the combustion gases. Sometimes a saving results in a rearrangement of the baffles to eliminate dead pockets and insure a uniform scrubbing action of the gases over the heating surfaces.

The boiler should be put in first class condition before being returned to service. Shut downs are expensive.

The feed water should be measured and fed to the boiler in a steady, uniform stream and if feed water heaters are part of your boiler room equipment they should receive careful attention. Both open and closed type heaters should be cleaned periodically. This is particularly important with the closed type if the recorded temperatures indicate dirty tubes. Hot water overflow of the open type heaters should be prevented.

Various gauges, instruments and appliances have been developed to aid us in our battle against waste in the boiler room. Without exception these are recommended because with intelligent use of such equipment still greater fuel economy is possible.

Steam.—All impurities in the steam are objectionable on account of the corrosive and erosive action on the steam lines, engine cylinders and turbine blades. To prevent these impurities, the concentration of salts in the vessel should be controlled, within safe limits, through an intelligent use of the boiler blow down. Great quantities of heat and water are sometimes wasted when this practice is used to excess and this is usually indicated by an unusual increase in feed water evaporated. Sometimes the blow off valves leak, wasting a continuous flow of heat units. A simple observation of the temperature of the blow off pipes, below the controlling valve will detect such loss and should be made daily.

It is economy to keep the water in the boiler, at a constant level and carry steam pressures as uniform as possible.

Steam Leaks.—Steam leaks represent additional fuel waste and their prevention means a real saving. There is no excuse for having a visible leak in your plant. The continuous waste through invisible steam leakage may become a very serious matter if neglected.

The safety valve on the boiler should be tight and only be allowed to blow during a safety test. Steam traps should be tested daily to determine if steam is passing through them. This may be checked easily by operating the atmospheric trap discharge valve. Leaky throttle valves or stop valves on steam connections will pass waste steam into idle pumps. This can be determined during your daily routine inspection simply by observing the temperature of all idle units. Leaks between steam cylinders and jackets are common. These can be determined by closing the throttle valve and with the jacket under pressure, open the indicator pipe valves. Steam leaks around rods can be entirely eliminated by proper attention to packing.

To conserve heat units and prevent condensation all live steam pipes should be covered. This also applies to lines carrying hot water and exhaust returns. Traps should be employed at all places where they are applicable and their discharge returned to the heater or feed water supply system.

Pumping Plant.—(a) Engine: The steam end of a direct acting triple expansion condensing engine requires little attention so long as it is properly packed and lubricated. The performance of each cylinder should be periodically checked by taking steam indicator cards. The efficiency of the pump should also be determined by occasional steam consumption tests at rated capacities. If the duty as calculated from the test shows an appreciable decrease from that guaranteed by the manufacturer, the engine in all probability needs attention. Trouble of this nature is also indicated by a decrease in the station duty.

The vacuum of a condensing engine is important and greatly affects cost. It is estimated that for every inch less vacuum than 25 inches of mercury the loss in economy in a Triple Expansion Engine is between two and three per cent. It behooves us then to watch our vacuum closely. A reduction in vacuum is invariably due to air leaks and these are usually found around the low pressure piston rods. It may be due also to scaled condenser tubes or the condition of the valves or packing in the vacuum pump. In any case a drop in vacuum should be vigorously followed up by a complete inspection and promptly corrected.

(b) Pumps: The water to be pumped in most cases has to be lifted, therefore the vacuum principle must be resorted to and again it is important that air leaks be overcome. Due to the limited height to which atmospheric pressure can force water it is essential to obtain as perfect a suction as possible. The inlet screen should allow easy and continuous flow. All air traps should be avoided and the pipe line and suction chambers be regularly inspected and kept air tight.

The great source of waste in the water end of a pump may be all summed up as pump "slippage." Ordinarily one thinks of slippage as only that water that slides past the plunger and rods. By far the greater amount is due to short piston stroking and defective valves. There are many plants where excessive slippages are allowed to run on continuously, a very flagrant practice when same can be corrected so easily. Usually all that is required is to tighten or replace the packing. A small amount of water is usually necessary to lubricate the plunger, therefore care should be taken not to pack too tightly for that increases the work to be overcome. Sometimes an internal inspection is necessary to locate the trouble. In this case all defective valves should be repaired or replaced. In general the admission and discharge valves should close tight, be prompt in action, allow large water way, and open freely. It is good practice to inspect these elements each time a pump is down for any length of time.

Priming valves or by-pass connections between the discharge and suction valve decks are sometimes left open through neglect. More often they are intentionally opened to relieve shock occasioned by air leaks or de-

fective valves. To fail to investigate the cause of the trouble and allow the valves to remain open is a practice that should be condemned.

Short stroking is a most common offense, especially in direct pumping service. I dare say most of you on your next visit to your station can observe a reciprocating pump stroking short. This is no small item if you consider that a 20-in. stroke losing 1 in. or 5 per cent, means a displacement loss in approximate like proportion for each pump cycle. This may be remedied by proper attention to those adjustments on the pump which control the length of the stroke. It is better where possible to use the cut off and cushion valves rather than the cross exhaust valves in this operation.

Up to this point we have discussed each operation or subject from a practical angle. Now let us view the whole picture and see what further steps can be taken to raise the efficiency of the entire plant.

Selective Operation.—The improper selection of pumping equipment for the various pumping conditions met with in water works practice results in no inconsiderable loss.

The average plant provides duplication of equipment and very often includes different types of machinery. Furthermore, each pump has a maximum efficiency at a certain load and sometimes a pump is designed for a very particular service. Therefore, the engineer must decide the pump or combination of pumps that will most efficiently handle each case. Usually a base load pump of such capacity to handle the average load is operated continuously with one or more reserve pumps to take care of the high rate periods.

Sometimes, with two similar pieces of equipment available one requires less steam. In all cases the engineer should know approximately the operating cost of each unit to determine this—the steam consumption must be known. Some plants have steam measuring devices for their large units but where this is impractical a duty or steam consumption test should be made periodically. With the operating cost of each unit known, selective operation is possible and will prove a very economical practice.

Records.—Numerous operating records are tabulated hourly on a station log sheet and other continuous records are obtained from recording charts. The purpose of such information is, First: to tell a complete operating story, and second: to reveal any irregularities. Unless they are used in this manner their full value is wasted and the plant performance suffers. One of my most interesting duties is the daily calculation of the station efficiency from these records and the discussion of the results obtained with the plant engineer. Interesting, because it reveals how well the job has been done.

There are several methods commonly used to determine the economy of a steam pumping plant. This measure of economy is termed "duty" and is the ratio of work done to energy used.

To calculate "duty" you must know—

11—Gallons of water pumped (from meter or pump counter)
12—Suction lift or head in feed (measurement or gauge)
13—Discharge head in feet (gauge)
14—Total dynamic head in feet (Item 13 plus or Item 12)
15—Foot pounds of work done per gallon pumped (Item 14 x wt. of 1 gal,. of water)
16—Mil. foot pounds of work done (Item 11 x Item 15) divided by 1,000,000
17—Equivalent work done in B.T.U. (Item 16 divided by 778)

Duty expressed as foot pounds duty per 100 pounds of coal

$$\frac{\text{Item 16} \times 100}{\text{Item 1*}} = \text{M.F.P. duty per 100 lb. coal}$$

Includes efficiencies of boiler and pumps or entire plant.

Duty expressed as foot pounds duty per 1,000 pounds of steam

$$\frac{\text{Item 16} \times 1{,}000}{\text{Item 4*}} = \text{M.F.P. duty 1,000 lb. steam}$$

$$\text{Overall thermal efficiency} = \frac{\text{Item 17}}{\text{Item 3*}}$$

**See "Boiler Efficiencies" Data for Items 1, 3 and 4.*

It is not enough to make a good showing one day and then fall off. To carry on this work the support of the entire station crew is necessary. To stimulate their interest a record of achievement is posted at the station. This may take the form of a curve or chart showing station efficiencies in terms that they understand.

Par Performance.—Some plants carry this idea of "Personnel Interest" one step further. A standard of efficiency is established for the station and called "Par Duty." This is very similar to par in golf, a possible attainment, but fairly difficult for most of us. This is determined by calculating the average amount of steam used per day. Manufacturers' guarantees and steam consumption tests made under perfect conditions are the basis for these figures. The amount of coal which would have to be burned to generate this quantity of steam is then calculated. "Par Duty" is this amount of coal divided into the average foot pounds of work done in pumping water under average head conditions.

The actual duty obtained by the plant is compared to the "Par Duty" established and is expressed in terms of per cent achievement. This plan is particularly adapted to a group of plants under one control for they can receive a comparable rating in the order of their per cent achievement.

Budget.—After the plant has been regulated to a high degree of operating efficiency a final step in the interest of greater economy is possible through the preparation of an operating budget. This part of the "Economy Plan" is of interest to the management for it expresses the efficiencies in dollars and cents. Briefly, this system consists of a set up of each operating expense item by months and for the entire year. The budget figures are determined by an analysis of past records but should be a little lower than previous accomplishments. The estimated figures should be constantly before the chief engineer and at the end of each month when the actual figures are added he knows how he stands.

Say, for example, his fuel cost for one month was estimated at ten dollars per million gallons and when the final figures are in, he observes that he spent ten dollars and eight cents. Naturally he will make every effort during the following month to catch up the amount he has fallen behind. This continual effort to achieve a goal is the purpose behind the plan.

Various methods have been mentioned to build up interest and encourage the men to greater efforts. Regardless of how intelligently your plant may be operated, to continue to be successful you must have the support of the men. One of the best ways to develop human interest is to make a game out of the work, explain the rules and they will do the rest. It's natural to want to win.

Acknowledgment.—The above was taken from a paper presented before the Arkansas Water Works Association at Fayetteville, Ark.

EDITORIALS

How Civil Engineers Can Accelerate Sanitary Progress

AMERICA is as backward today in treating its sewage as it was 30 years ago in treating its water. State boards of health have brought about the installation of sewage disposal plants in many cities, but usually this has occurred under duress. The fact is that most cities have ignored and continue to ignore the advice of boards of health and of civil engineers as to the need of sewage disposal plants. The consequence is that streams, lakes and oceans are polluted to a degree that is inexcusable.

The main reason for public opposition to sewage treatment is not ignorance but unwillingness to pay the bill, particularly that part of the bill that represents the first cost of the plant. If sewage disposal plants were to receive an annual income, like water works, then much of the public opposition to them would disappear, for the annual rentals or service charges would be so very small as to be almost unobjectionable. It was partly this consideration that led to the passage of the Ohio Sewer Rental Law in 1923, and a similar law in Michigan in 1926 (see WATER WORKS AND SEWERAGE, Nov. 1929, for full drafts of those laws). In both states a city or town may charge rentals for all or part of a sewerage system. In Michigan cities, villages and counties, individually or collectively, may issue bonds for sewerage systems upon which rental charges may be imposed; but the bonded indebtedness must not exceed 60 per cent of the total cost.

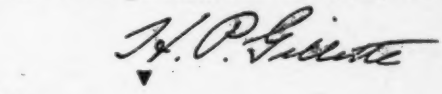
Similar laws should be passed in every state, but the laws just mentioned should be modified considerably if there is to be a rapid development of adequate modern sewerage systems.

In the highway field civil engineers were mainly responsible for the state-aid laws and for the gasoline tax laws that now exist in every state. The writer speaks from personal knowledge as to this matter. Up to the time that state-aid laws were enacted, scarcely any progress occurred in road improvement. Not until the gasoline tax, which is really a toll, became common, did highway improvement occur at a rate that was at all satisfactory. The rapid growth of the highway industry is therefore due mainly to laws that provide for payment for the use of the highways in the form of a toll called the gasoline tax. If civil engineers will follow the precedent established in the highway field, and secure the passage of sewer rental laws in every state, the first great step will have been taken toward the goal of practically universal sewerage treatment.

It has been suggested by Mr. N. T. Veach, Jr., that sewer bonds should be a general obligation upon a city, for this would make them marketable at lower rates of interest. We urge that such bond issues be not limited to a fraction of the cost of the plant, but that the full cost be paid for out of bonds having not less than 30 years to run. The prime object is to reduce the annual rental charges to a figure that is so small as to arouse no opposition to sewerage treatment. Bonding up to the full cost, low rates of interest and long terms to maturity will accomplish this purpose. Bonding to the full cost will be feasible if the bonds are a general obligation bonds.

Another desirable feature of such laws will be the provision that indebtedness shall be say 4 per cent of the full market value of all real estate in a city plus the full cost of all self-supporting utilities, such as water works and sewerage systems that receive revenue sufficient to pay interest upon and amortization of their bonds.

A civil engineer is primarily a construction economist. But if he is to be of greatest usefulness to society he must at times become a political economist. It is not sufficient to advise as to the wisdom of building or improving a sewerage system, for example. He should be a leader in bringing about public acceptance of his advice. This can be accomplished in many ways, but in no way so effectively as by providing legal means of securing a small but steady revenue from a public utility, either directly as in the case of sewer rental, or indirectly as in the case of the gasoline toll for the use of the highways.



Cleaning Mains

ONE of the most informative papers presented at the recent Convention of the New England Water Works Association in Springfield, Mass.—printed in abstract elsewhere in this issue—was that by Arthur T. Clark, Division Engineer and Superintendent, Greenwich Water Co., Greenwich, Conn. It had to do with the advantages derived from systematic cleaning of water mains and the first hand experiences of the author in this maintenance practice. Judging from the results obtained from main cleaning by the author's companies, and those reported by discussors of his paper, the term maintenance practice might more properly be changed to "rejuvenation procedure." Mr. Clark reported, that at New Rochelle, N. Y., main cleaning had returned a 16 inch pipe line to its original (new) value after corrosion and tuberculation had already reduced its carrying capacity to that of a new 10 inch main and by cleanings given but twice yearly the original carrying capacity of new pipe had been maintained. Discussors of the paper gave such first hand experiences, as having reduced pumping costs and increased pump efficiencies to remarkable degrees by relatively inexpensive cleaning operations. The results from long supply main cleanings at Troy, N. Y., and Cambridge, Mass., had been in effect the saving of installation of new mains otherwise needed to parallel those existing. Such experiences, with 33,000 feet of 16 inch main at Troy, N. Y., with 9,000 feet of 30 inch main at Cambridge, Mass., and 7 miles of 16 inch main at New Rochelle, N. Y., and in addition the reported net savings of $4,800 per year for pumping 3 million gallons per day through a 6 inch main after cleaning, justifies the attention of water works men to main cleaning in a systematic manner.

Perhaps cleaning of water mains would be more universally practiced except for the apparently erroneous idea that cleaning operations are difficult, and that tuberculation proceeds more rapidly after cleaning than before because of removal of some of the protective coating from the interior of the pipes. In modern practice as outlined by Mr. Clark, none of these objections hold as evidenced after four years of cleaning of one main. When facilities for cleanings have been properly provided in advance, the operation becomes simple, rapid and non-hazardous.

Mr. Clark calls attention to chemical treatment of

water employed to effectively retard the progress of tuberculation of mains and thus reduce the frequency of necessary main cleaning operations. It would appear that lime application to maintain a slightly alkaline water in the mains—the pH value required being a matter to determine for each particular water to render it non-tuberculating and non-aggressive toward metallic iron—supplemented by systematic main cleaning will maintain the carrying capacities of mains at that closely approximating their value when newly laid. Chemical treatment of waters very low in mineral or organic content is apparently in itself not sufficient to completely stop tuberculation unless the pH value of the water be raised to an impractical degree of alkalinity, objectionable for industrial and domestic usage.

Sewers constructed of light weight cast iron pipe have been installed in the Washington Suburban Sanitary District with economy in costs of installation and also in investment charges when considered over the period of estimated life and service of the gravity lines in terms of maintained carrying capacities. Sewers have been for some time constructed of cast iron pipe when run above ground on piers or trestle work and when serving as force mains.

Tuberculation of sewers above the flow line may eventually prove of some concern when the line becomes surcharged, but the more important elements in reducing carrying capacity will probably be the biological slime coating and grease and lime-soap deposits built up by the sewage on the walls of the pipes. Cleaning of sewers should prove a simple and inexpensive operation and return the line to its original carrying capacity if and when deposits after years of service justify such cleanings. Sewage force mains and ocean outfalls have already been successfully cleaned in America by running pipe cleaning machines through them and with economic benefit. Cast iron pipe for sewers offer specific advantages and bid fair to compete generally with other pipe in sewer construction in the future. With periodic cleaning operation there seems little to be feared concerning reduced carrying capacities with increasing age.

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The R. F. C. and Small Projects

IT is encouraging to note two recent additional awards of aid by the Reconstruction Finance Corporation to municipalities for use in water works betterments. Ogden, Utah, will receive $695,620 for improvements to its water supply system and Prescott, Arizona, $50,000 for construction of increased reservoir capacity. In both instances the R. F. C. purchased the bonds of the city. The most interesting feature of the Prescott matter is the fact that small projects receive consideration as well as tremendous ones such as the Los Angeles Metropolitan Water District requiring $40,000,000—the latter, incidentally, being the first grant made by the R. F. C. to self supporting public works of any nature.

Of considerable value to municipalities that need guidance in the preparation of applications for R. F. C. aid, is the offer of the American Engineering Council to supply the services of competent engineers to assist municipalities without compensation. The plan is to appoint on each of the thirty-two regional advisory committees of the R. F. C. an outstanding consulting engineer who will give his time gratis to assisting in the preparation and presentation of applications. Such service will be especially helpful to municipal officials who may wish to file application for loans to cover small projects, wherein the cost of engineering advice cannot be afforded at this time. Such engineering service, however, in no wise supplants engineering service in connection with subsequent actual construction of projects for which loans may be granted.

The benefits to be derived from a number of small projects are equally as important as those from a fewer large projects. The small projects perhaps offer greater benefits inasmuch as the plans and actual betterments can be gotten under way more promptly than can larger ones. Furthermore, the work will be scattered and a greater number of municipalities will thereby have work to offer the unemployed and a greater number of taxpayers will benefit from the low interest rates to be charged. The Cast Iron Pipe Research Association, in their nation wide advertising campaign to interest taxpayers in a "help your community and thereby help others" movement, are stressing the fact that 100 tons of cast iron pipe produced requires a full day's work by 740 men. Besides employment given local labor, seven industries are primarily involved in the production of cast iron pipe, from the mining of the raw materials involved to the delivery of pipe to users. Thus it is readily apparent that sufficient small projects if added together will require enough pipe, fittings, valves, hydrants, etc., to start the wheels of the water supply materials industry going, and once started they should keep moving.

The Executive Committees of the New England Water Works Association and the Water Works Manufacturers' Association were frankly disappointed in the slow progress made by the R. F. C. in approving loans for water works betterments, and said as much in a letter addressed to the Director of the Corporation: since then more loans have been granted. The same committee in its communique directed attention of municipal officials to the need for quick action in the matter of preparation of plans and filing of applications for loans, if anything of real value in unemployment relief is to result during the critical Winter approaching.

With the R. F. C. looking with favor on loans for small projects, with the availability of engineering assistance gratis and with advantageous money terms, water works and sewerage officials should be quick to take advantage of this opportunity to help and in turn be helped. Application for R. F. C. assistance has in several instances, notably at Pasadena, Calif., caused local banking interests to advance funds needed, at rates and under terms equally as attractive as those offered by the R. F. C. To secure financial assistance at home is to be preferred and an application to the R. F. C. may well prove all that is necessary to produce the desired result.

Since the above was written the Reconstruction Finance Corporation has approved the following loans for water works:

Wilmette, Ill., $580,000 for construction of municipal water works; Seattle, Wash., $1,491,000 for improvements in the municipal water works; Roanoke Rapids, N. C., $365,000 for a municipal water works and sewerage system; Sandusky, O., $77,000 for construction of sludge basin for the water works; Conneaut, O., $200,000 for improvement of water system; Maysville, Ky., $47,000 for a filtration plant; Columbia, Ky., $29,000 for completion of the water supply system.

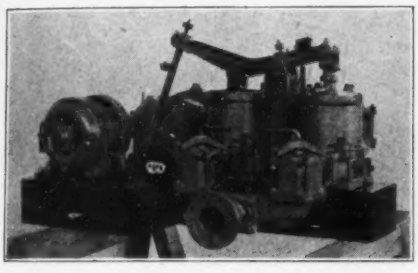
All the above loans were made through the purchase by the Reconstruction Finance Corporation of the municipal bonds. It is interesting to note that part of the loan for Roanoke Rapids, N. C., is for sewerage. This is the first loan made by the Reconstruction Finance Corporation for work of that kind.

L. H. Enslow

NEW EQUIPMENT AND MATERIALS

Chain Belt Company Offers Rex Sludge Pumps

The Chain Belt Co. of Milwaukee, Wis., have perfected the Rex Sludge Pump as an additional piece of equipment added to their line of diaphragm pumps and other sewage plant appurtenances. These pumps are of the plunger type—single or double plunger styles being available as stationary or portable units. These pumps are used for handling raw digested sludges, activated sludge or humus from secondary tanks. They are capable of pumping with a 25 foot suction lift and discharging against a head of 65 feet. Capacities are 75 gallons per minute for the single and 150 gallons per minute for the double plunger units. Standard units come equipped with multi-speed motors and herringbone-gear speed reducers equipped with Timken bearings. Stroke of plunger



Rex Double Plunger Sludge Pump, Multi-Speed Motor and Speed Reducer Equipped

is adjustable to secure 3, 4 or 5 inch displacement. The walking-beam drive employed means long life of pump because there is practically no side thrust to create wear on plunger and cylinder. With flap type valves a clear opening of four inches through the entire pump is had which reduces possibility of clogging to a minimum. The valve cases are equipped with quick removable covers. Another unique feature of the pump is that the packing is in the plunger instead of the cylinder wall. With the several speeds and three variable stroke adjustments, the ratio of minimum to maximum capacities is one to six. Heavy construction is used throughout, making the pump a very sturdy unit. For more detailed information write the Chain Belt Co. (Division of Sanitation Equipment), Milwaukee, Wis.

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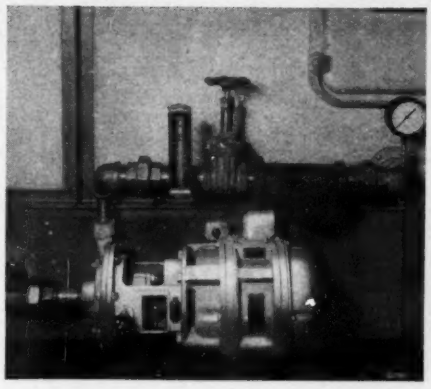
Cameron "Motorpump" Offered by Ingersoll-Rand

The Cameron Motorpump is a compact and complete pumping unit with built-in G. E. motor of the open, totally enclosed or explosion proof type as desired. These units are readily portable and come in sizes from ¼ to 25 h.p., good for 5 to 800 gallons per minute, which in the words of the Ingersoll-Rand Company are "intended for general service everywhere," which in-



"Motorpump" Operating on Hot Water Recirculating System.

cludes emergencies, as well as general utility. Its small size, high efficiency and ability to operate in any atmosphere or any position adds to its advantage as a general purpose pump unit in many situations where conventional pumps would be unsatisfactory. It can be mounted vertically on the inside of manholes and tanks and others are operating on their sides or upside down. In the "Motorpump," couplings are eliminated and there are but two dirt proof ball bearings producing pump efficiencies of 82 per cent—hitherto unattainable for small pumps. "Motorpumps" come entirely bronze-fitted unless otherwise specified. For use with highly corrosive liquids such as solutions of ferric-chloride, alum or chlorine water, resistant alloys are used.

The "Motorpump" is exceedingly light—the ¼ h.p. unit weighing but 55 lbs., and takes up less space than is covered by this magazine open on your desk. It is only 15 and 11/16 inches long by 8 and ¾ inches wide, but it will deliver 5 to 60 gallons of water per minute against heads as high as 55 feet. The largest size unit (800 gallons per minute) is but 3 feet long by 18 inches high.

"Motorpump" units of all sizes are carried in stock, ready for immediate shipment, by all Ingersoll-Rand Company branch offices and distributors. For additional information write Ingersoll-Rand, 11 Broadway, N. Y. C., for their new Cameron "Motorpump" Bulletin.

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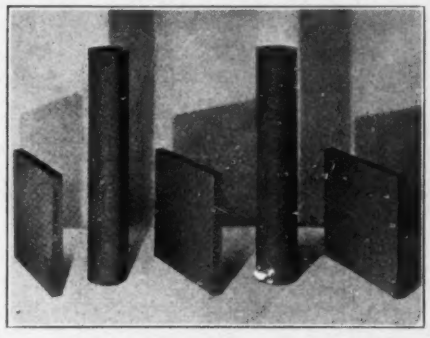
"Aloxite" Air Diffusors for Water or Sewage Aeration

The Carborundum Company of Niagara Falls, N. Y., have just recently issued their Engineering Bulletin No. 1, describing air diffusor plates and tubes made of carborundum.

In this publication the qualities and characteristics of the several grades of "Aloxite" carborundum diffusor plates and tubes are discussed and illustrated by graphic charts. One graph shows the pressure losses at varying rates of air diffusion when plates of the several different porosities are employed. It is claimed that "Aloxite" diffusors will furnish the smallest size bubbles, combined with the lowest pressure loss for any given capacity, of any material on the market.

"Aloxite" plates or tubes can be obtained with permeability ratings ranging from 4 cu. ft. per minute to 60 cu. ft. per minute. Standard size plates are 12″x12″x1″ and standard tubes are 24″ long and 3″ internal diameter and ⅝″ wall thickness.

The Carborundum Company maintains a permanent research laboratory and a technical and sanitary engineering staff which are at the service of consulting engineers, city engineers, or others interested in aeration problems, particularly the ac-



"Aloxite" Diffusor Plates and Tubes.

tivated sludge process of treatment of sewage and water aeration, mixing, etc.

Engineering Bulletin No. 1 is worth writing for—address The Carborundum Company, Niagara Falls, N. Y., attention —Sanitary and Filtration Department.

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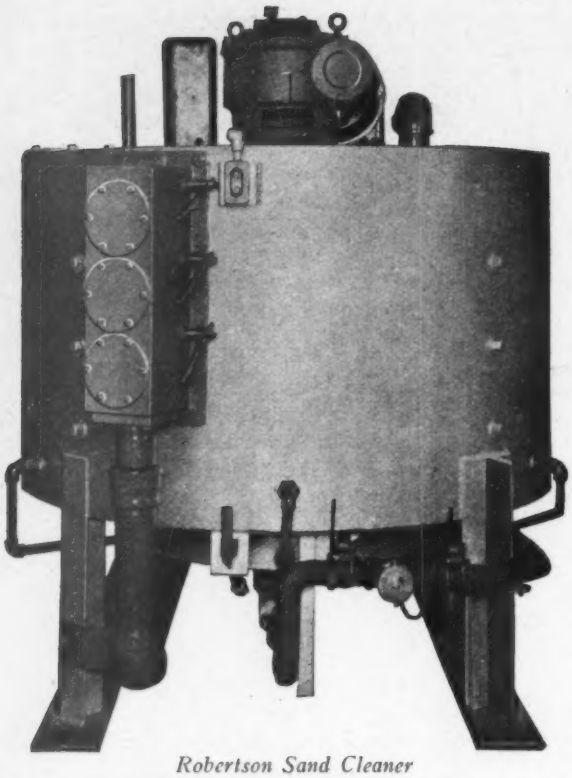
The Robertson Sand Cleaner

In recent years considerable attention has been devoted to maintaining filter sand in the cleanest practicable condition. Many schemes have been tried, including caustic soda treatment with extraordinary high velocity filter wash.

Faced with the problem of cleaning the existing sand or purchasing new sand to replace the dirty sand in the filters at the Richmond, Va., filtration plant, a highly efficient and novel sand cleaner and grader was built and used. The machine handled two tons of sand per hour, taking the dirty sand from the filter and returning it to the same unit with less than one per cent foreign matter content remaining. Since then the Robertson Sand Cleaner has also been used at other plants effectively. Sturdily constructed, with a minimum number of moving parts, it operates with speed, efficiency and economy. By a compound rotary (whirlwind) movement, the machine sets up a violent bombardment of sand grains against other sand grains and thus literally sand-blasts off the organic or inorganic coatings. The mud and organic



Robertson Sand Cleaner

matter are carried out by a minor flow of water through the washing chamber and the cleaned sand is delivered to the storage bins or filter. The dirty sand is delivered to the cleaner through a hose line from an ejector hopper placed in the filter, the cleaner proper being set up at any convenient location inside or outside of the filter building.

The Simplex Valve and Meter Company, 68th and Upland Streets, Philadelphia, Penna., have recently announced that the Robertson sand cleaner is being marketed through them. Simplex Bulletin No. 55 describes this ingenious machine which is available in three different sizes.

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The New PFT Clarifier

A series of practical tests covering many months have been completed by the Pacific Flush-Tank Company on a compact, efficient and economical clarifier employing new and advanced ideas in the separation of solids from liquids in the fields of sewage, water and trade wastes treatment.

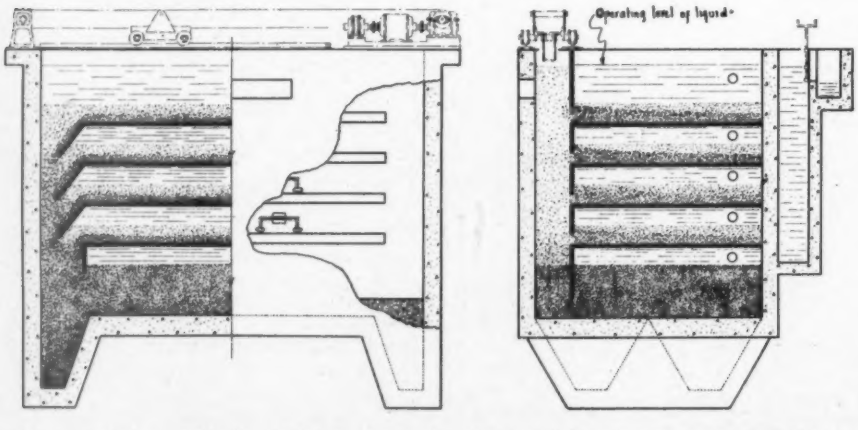
The apparatus has been designed on basic sedimentation principles, and, in addition, introduces methods for the effective handling of flows, controlling of velocities and the elimination of short circuiting. In general it departs almost completely from present practice of equipping sedimentation basins with mechanisms, for the removal of sludge.

The illustration shows in a diagrammatic manner the principles employed in this new development. Briefly, liquids containing solids in suspension are distributed from a feed channel into the lower portion of a number of settling compartments. The entire depth of the tank itself is effectively used to provide, not one, but a number of decanting areas. The clarified liquid is removed from each one of these decanting areas by means of a collecting manifold. The rate of flow of liquid from each one of the collecting areas is controlled by an easily adjusted weir on the outside of the tank. Since the incoming liquid is distributed completely along the lower portion of each one of the settling areas, the straining action of the solids, which are allowed to accumulate on the trays, is employed to advantage in the removal of non-settling materials from the liquid which would not ordinarily be removed by plain sedimentation.

The sludge which accumulates is continuously moved by the multiple scraping mechanisms operating on each tray to the sides of the tank. Here it drops into a concentration hopper. This provides an effective means of concentrating the sludge before it is removed from the basin. Any practical size or depth of sedimentation unit can be constructed for any type of sedimentation problem.

Based upon many months of testing at the experimental plant of the company, followed by tests at an activated sludge plant under practical operating conditions, the manufacturers claim the following principal advantages for the device: (1) Greatly increased sedimentation capacity over existing types of clarifiers of equal cubical capacity. For equivalent depths of units three or four times the capacity can be obtained. (2) Sludge densities greatly in excess of those now being obtained. (3) Reduction of normal detention times by approximately two-thirds because of the effective means of controlling distribution of flow and making use of the entire tank volume. (4) Considerable saving in the initial cost of the installation and operation due to the simplicity and compactness of the unit. (5) Ease of control of operation due to the flexibility which can be obtained. (6) Increased settling rates of material difficult to separate by means of the combination of screening and settling actions.

Many new thoughts in sedimentation, test data and interesting methods of applying well proven principles, are contained in a bulletin which will be sent upon request to the Pacific Flush-Tank Company, 4241 Ravenswood Ave., Chicago, or 136 Liberty St., New York City.

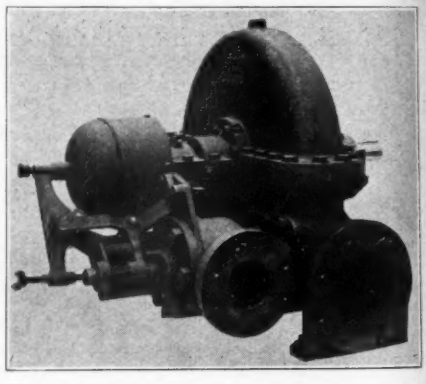


Cross Section Showing Distribution of Material Passing through Clarifier

▼

New Mechanical-Drive Turbine Announced by General Electric

A new mechanical-drive, noncondensing steam turbine for driving centrifugal pumps, fans, and other rotating equipment has been developed by the General Electric Company. This turbine is suitable for driving equipment at speeds from 1200 to 4000 r.p.m. and is available up to 250 h.p. under suitable steam conditions. The new turbine is a single-stage machine with two rows of revolving buckets. Simple in construction, it is an addition to the standard line of General Electric mechanical-drive turbines. The wheel casing is split horizontally to allow easy access to the internal parts and the steam and exhaust pipes are connected to the lower half of the machine. A centrifugal governor, with weights pivoting on knife edges, operates with very little friction and provides proper speed regulation. An independent emergency governor is included. The new turbine bears the type designation D-59 and, except for being larger, is similar to type D-57.



General Electric Steam Turbine Type D-59

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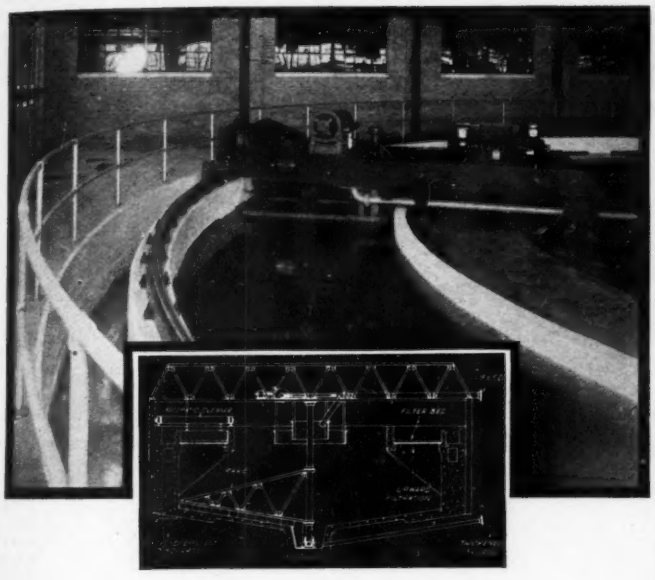
LAUGHLIN CLARIFYING TANK

For the Better Removal of Suspended Solids from Sewage and Industrial Wastes



—Permits of usual sedimentation and thickening operations within a tank, at high capacity for a given tank size.

—Removes solids by positive filtration.

—Filter bed embraces entire circumference of tank, extending inwardly five feet or more.

—Operated with a traveling magnet which cleans the filter bed as necessary.

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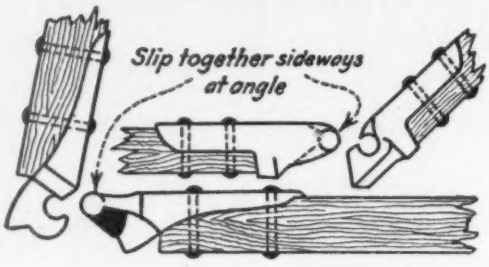

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In order to complete files for binding, copies of the May, 1931, and October, 1931, issues of WATER WORKS AND SEWERAGE are needed. Any subscriber supplying either of these issues will have his subscription extended for two months. A copy of the March, 1928, issue also is wanted. A subscription extension of 6 months will be given any subscriber furnishing this copy. Gillette Publishing Co., 865 Daily News Building, Chicago.

WATER WORKS SUPERINTENDENT—22 years' experience in operation and management of water works. Seventeen years as superintendent in metropolitan area of 50,000 population, in charge of three separate water works systems. Experienced in managing water softening and deep well supplies, including location and drilling. Salary secondary consideration. Age 46. Address "F. E. S.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

ASSISTANT CIVIL ENGINEER—Age 26. Single. Newark Tech. graduate. 7 years' experience. Assistant engineer on highway and sewer work. Sewer inspector. Able draftsman. Stenography and typist. Location immaterial. Address "J. D. S.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

CIVIL ENGINEER—Age 27. I. C. S. graduate. 10 years' experience in sewerage and highway work. Resident engineer on several large sewer contracts. Good draftsman. Location immaterial. Excellent references. Address "A. J. G.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER-CHEMIST — More than 20 years' experience in all phases water purification, sewage treatment and industrial wastes and stream pollution investigations. Experience in actual plant operation and special experience and accumulated data on industrial wastes and sewage treatment. For eleven years in charge of water supply, sewage and stream pollution work for one of the more active of State Health Departments. Permanent or temporary work desired. Address "G. C.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

ENGINEER-SUPERINTENDENT—B. S. in Sanitary Engineering. 13 years experience in operation of large and small sewage treatment works and experimental sewage treatment, activated sludge, Imhoff tanks, sprinkling filters, pressing, filtering and heat drying of sludge. Married. Age 34. Address "R. S. S.," Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

POSITIONS WANTED

This department has been started as a service to those in the Water Works and Sewerage Fields. We hope they will make use of it. The notices are inserted without charge.

ENGINEERING SALESMAN, age 36, university graduate 1916, with chemistry major. Eleven years engineering sales experience contacting public officials and contractors on municipal, county, state and government public works. Last three years in Minnesota, Wisconsin and Northwest. Previously four years calling on irrigation and reclamation projects, water works, hydroelectric companies, in California and other Pacific Coast states. Good sales record with largest companies. Available immediately for service anywhere. F. L. M., Water Works & Sewerage, 400 W. Madison St., Chicago, Ill.

RESEARCH AND CONTROL CHEMIST—B. S. in chemistry from eastern university. Three years' experience in industrial research on water treatment and boiler-plant control. Now associated with large research organization working on ammonia-chlorine process. Desire position as operating chemist or research development. Available immediately. Salary no consideration. Excellent references. Age 24. Are you keeping step with advances in water chemistry? Address "G. H. Y.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER—27 years old; at present water works chemist in small town, three years water works and sewerage experience, B. S. and M. S. in Civil Engineering, desires change to large city or industry having domestic sewage and industrial wastes disposal problems. Modest salary to start, with increase as ability is shown. Address "A. B. U.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

REGISTERED CIVIL ENGINEER—M. S., Mass. Inst. of Tech.; one year surveying on municipal construction; 3½ years of engineering research and materials testing, mostly on sewer construction in large city. Age 27. Excellent references. Trained in hydraulics and soil mechanics. Address "R. G. H.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

WATER PURIFICATION SUPERINTENDENT, married man, desires position as Superintendent or Assistant Superintendent of a municipal or industrial water plant. Familiar with all details of water purification and water softening including chemical and bacteriological analyses. Has been in charge of an industrial plant for seven years and experienced in handling men. Address "D. A. C.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

SANITARY ENGINEER, B. S. in Sanitary Engineering 1929. Experience as inspector and instrumentman in highway and railroad construction. Drafting experience with The Truscon Steel Company. M. S. in Sanitary Engineering 1932. Location immaterial. Salary no consideration. Available immediately. References. Address H. J. H., % Water Works and Sewerage, 400 W. Madison St., Chicago, Illinois.

WATER WORKS SUPERINTENDENT—Three years' experience in charge of water works in city of 15,000 population. Prior experience: Eight years in charge of filtration plants in city of 100,000 population and one year in charge of sewage treatment works. Position desired as superintendent or assistant superintendent of water works, sewerage, or both. Age 36; married; American, and college graduate with C. E. degree. Immediately available. Address "W. W.," % Water Works and Sewerage, 420 Lexington Ave., New York City.

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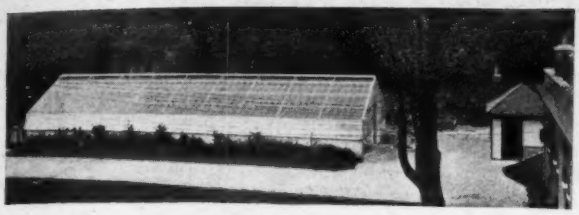
Glass-Overs for Sludge Beds



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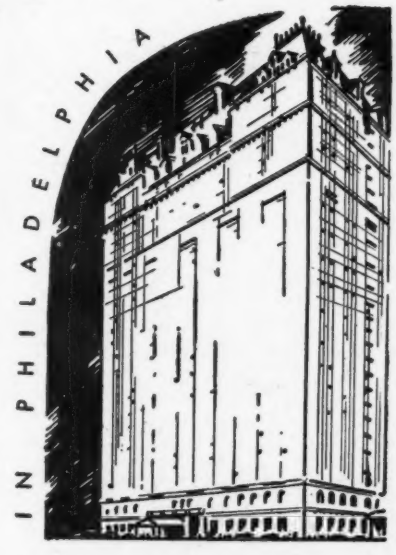

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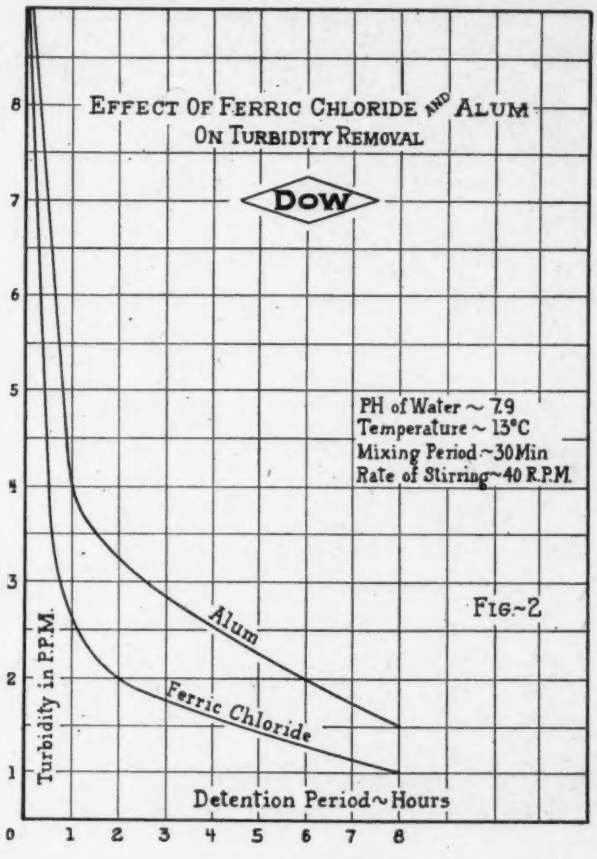
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Rate of Stirring ~ 40 R.P.M.
Alum
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Turbidity in P.P.M.
Detention Period ~ Hours
0 1 2 3 4 5 6 7 8
1 2 3 4 5 6 7 8

FIG.-2

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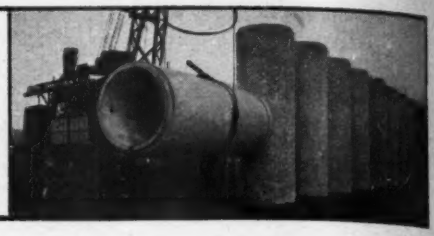

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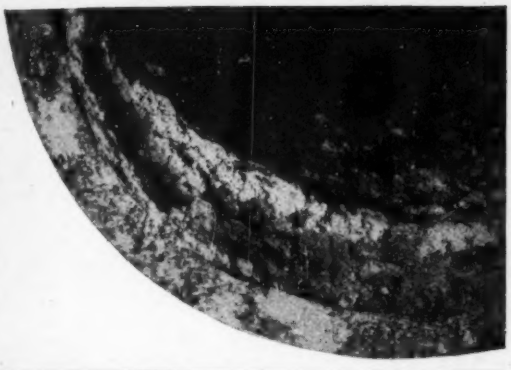

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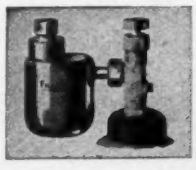

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ABP

November, 1932 — L. H. Enslow, Editor — Vol. LXXIX. No. 11

New Tank of the Baltimore Water Department, Located at Towson, Md. The Design of This Tank Won First Prize for the Designer, Eugene Yoita.

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Some Water Works Lessons Chicago Has Learned from the Depression

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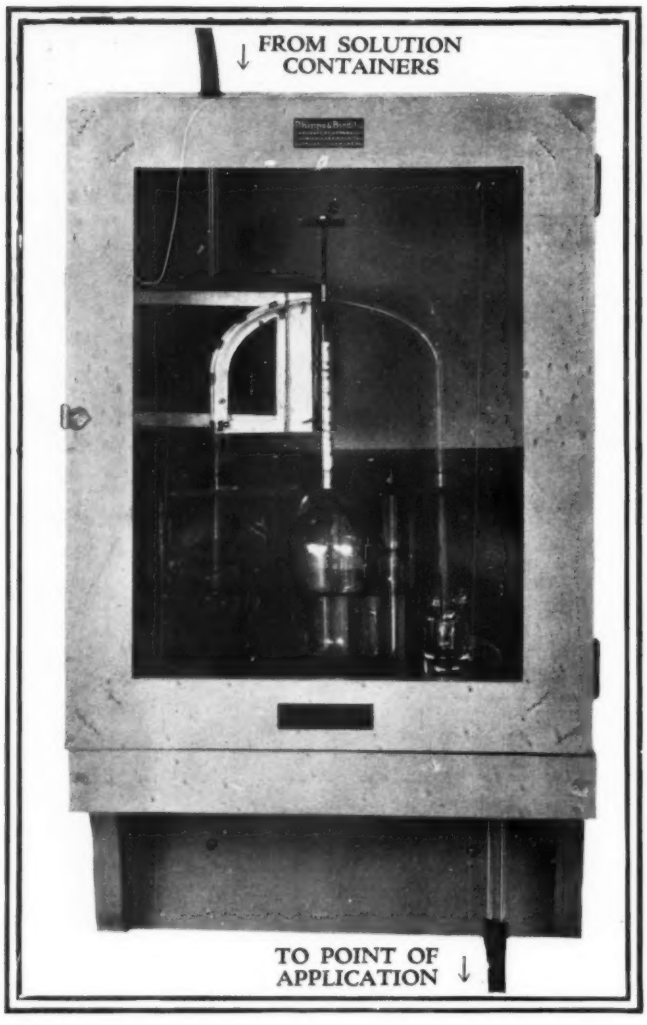
Reports of Meetings of New England Sewage Works Association, New York State Sewage Works Association and California Sewage Works Association

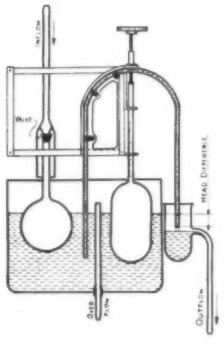


A NEW IDEA
IN CHEMICAL FEED EQUIPMENT

FEATURING—

- Simplicity
- Accuracy
- Constancy of feed
- Resistance against corrosion
- Accessibility of parts
- Low initial cost
- Low maintenance cost

An automatic valve arrangement, available as an accessory, switches on a full tank of solution when that in use runs empty.



The ability of this apparatus to feed even the most corrosive chemicals, its simplicity of design and readiness with which it can be dismantled and re-assembled renders it attractive in the sanitary field, for use in industral plants or wherever application of chemicals is involved.

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Complete details will be sent on request

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